Popular Science

MONTHLY *Founded 1872*

August 1928
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In this Issue

Speed and Thrills in Water Flivvers – Page 38

8 Timely Aviation Features

These are the oil companies which mix and sell

ETHYL GASOLINE

—the motor fuel that knocks out that "knock" and gives high compression performance

American Oil Company
American Ethyl

Anglo-American Oil Co., Ltd.
Pratt's Ethyl Petrol

Ashland Refining Company
Red Pepper Better Ethyl

Associated Oil Company
Associated Ethyl

Atlantic Refining Company
Atlantic Ethyl

Beacon Oil Company
Colonial Ethyl

Continental Oil Company
Conoco Ethyl

Crystal Oil Refining Corp.
Crystal Ethyl

Empire Oil Works
Empire Ethyl

Humble Oil & Refining Co.
Humble Ethyl

Imperial Oil, Limited
Imperial Ethyl

Johnson Oil Refining Co.
Johnson Ethyl

Kendall Refining Company
Kendall Ethyl

Liberty Oil Company, Ltd.
Liberty Pep Ethyl

Louisiana Oil Refining Corp.
Loreco Ethyl

Mexican Petroleum Corp.
Pan-Am Ethyl

A. D. Miller Sons' Company
Miller's Ethyl

Pan American Petroleum Co.
Pan-Am Ethyl

Pennsylvania Refining Co.
Penreco Ethyl

Pennzoil Company
Pennzoil Ethyl

Refiners Oil Company
Refiners Ethyl

Root Refineries, Inc.
Red Chief Ethyl

Solar Refining Company
Solar Ethyl

Spears & Riddle Company
Fleet Wing Ethyl

Standard Oil Co. (Indiana)
Red Crown Ethyl

Standard Oil Co. (Kentucky)
Crown Ethyl

Standard Oil Co. of Louisiana
Standard Ethyl

Standard Oil Co. (Nebraska)
Red Crown Ethyl

Standard Oil Co. (New Jersey)
Standard Ethyl

Standard Oil Co. (Ohio)
Red Crown Ethyl

Sterling Oil Company
Sterling Ethyl

Texas Pacific Coal & Oil Co.
T.-P. Ethyl

Tide Water Oil Company
Tydol Ethyl

Union Oil Co. of California
Union Ethyl

Walburn Petroleum Co., Inc.
Walburn Ethyl

Waverly Oil Works Company
Waverly Ethyl

In addition there are hundreds of resellers

ETHYL is in good company

WHY are these companies mixing ETHYL with their already good gasolines? To enable you as a car owner to get maximum efficiency from whatever car you may be driving.

ETHYL GASOLINE CORPORATION

25 Broadway, New York City — 56 Church Street, Toronto, Ont., Can.

A Spirit of Fair Dealing Controls the Used Car Department

The Cadillac-La Salle dealer is more than customarily careful, in selling used cars, to see that the buyer's satisfaction is secure.

Why?

Because a spirit of fair dealing—the spirit which has been typical of the Cadillac-La Salle business for more than a quarter-century—controls the used car department as well as the new car and service departments.

Fair dealing assures success.

First,—it builds that good will, trust, and friendliness which may, some day, make the used car customer into a new Cadillac or La Salle owner.

Second,—it brings the used car customer back when he is ready to buy again.

Third,—it inspires many customers to recommend the Cadillac-La Salle dealer to his friends who want good used cars.

CADILLAC MOTOR CAR COMPANY

Division of General Motors

Detroit • • • Michigan

What is a Good Used Car?

How can a buyer make sure of 100 cents' worth of good used car for his dollar? What should a good used car provide?

You will find profitable used car facts in the booklet, "What a Good Used Car Can Give You." A copy free, without obligation, on request—or your Cadillac-La Salle dealer will gladly supply you. Use the coupon.

Write for this booklet

CADILLAC MOTOR CAR COMPANY PSM—8-28
DETROIT, MICHIGAN

Since it does not obligate me, I should like ..... copies of your booklet of facts, "What A Good Used Car Can Give You."

Signed...

Address...

City.............................State.....................

WHAT IS NEW THIS MONTH

Table of Contents for August

LEADING ARTICLES

RADIO

THE HOME WORKSHOP

Astronomy

Automobiles

Aviation

Engineering

Health and Hygiene

Laboratory Discoveries

August, 1928, Vol. 113, No. 2. Popular Science Monthly is published monthly at 250 Fourth Avenue, New York, N. Y., by the Popular Science Publishing Co., Inc. Entered as second-class matter Dec. 28, 1918, at the Post Office at New York under the act of March 3, 1879; additional entry as second-class matter at Chicago, Illinois. Entered as second-class matter at the Post Office Department, Canada. Printed in U. S. A. Single copy, 25 cents. Yearly subscriptions to United States, its possessions, and Canada, $2.50; foreign countries, $3. In presenting in its editorial columns numerous stories of new products of applied science, Popular Science Monthly does not underwrite the business methods of the individuals or concerns producing them. The use of Popular Science Monthly articles for stock-selling schemes is never authorized. O. B. Capen, President and Treasurer; R. C. Wilson, Vice-President; A. L. Cole, Secretary.

Models

New Devices for the Home

New Processes and Inventions

Radio

Ships

Unusual Facts and Ideas

For the Home Owner

Hints for the Mechanic

Ideas for the Handy Man

WHAT IS COMING NEXT MONTH

¶ Television, or seeing by radio, is coming, they say. You will sit in your study and see on a screen the moving march of distant events. Far-away friends will smile at you as if you and they were face to face. But when? You'll know the truth about television when you read how far today's experiments have really progressed toward practical success.

¶ What is sulphur good for? "To burn," you might reply, and so it is. But did you know that not long ago a chemist discovered that it can also be used for making a variety of things ranging from toilet articles to radio loudspeakers? And that is but one example of the amazing new uses that have been found for chemical elements. A fascinating article will tell how many such new uses have been found for long familiar elements and enriched their discoverers; and of the rewards that await future discoverers.

¶ Do you know how to have your picture taken? It sounds simple—but there is more to it than you think. An absorbing article next month reveals the secrets of getting a good likeness, and the interesting foibles of great men who have sat before the camera.

¶ A man peers through a microscope and sees swarming creatures so tiny that thousands of them could cavort on a needle's point. "How mighty am I," he observes, "compared with these!" Another man sits at the eyepiece of a giant telescope, his eyes boring into the immensity of space and its vast systems of churning worlds. "After all," he reflects, "how insignificant is man amid such grandeur!" Which is right? A college professor tells, next month, where man really stands in relation to the universe—whether he is a giant or a pygmy.

AND important articles that will keep you abreast of latest thrilling advances in aviation and engineering—special new home workshop, radio, and automobile features

Mrs. Chatsworth *Increases the Value of* Public Utility Shares

By WALLACE AMES, *Financial Editor*

"WHAT day is this?" casually inquired Mrs. Chatsworth, as her husband picked up the paper to look over the radio programs for the evening.

"It's Wednesday, the 20th," replied Mr. Chatsworth, glancing at the newspaper date line for confirmation.

"That's what I thought," remarked his wife in a tone that aroused Mr. Chatsworth's curiosity.

"What's in the back of your little old beano, that makes you ask me the date when you know what it is?"

"Nothing much, but there's something out in the kitchen you ought to look at."

Before tuning in for the Cities Service Hour, Mr. Chatsworth made an excursion into the kitchen to see what his wife was going to spring on him this time. There before him stood a big, white electric refrigerator.

"So that's where that fancy frozen dessert we had tonight came from," ejaculated Chatsworth. "Where did you acquire this new piece of efficiency?"

"I got it from the electric light company. Arranged to have it delivered today—the twentieth of June—to celebrate our eighth wedding anniversary."

"So it is. So it is," said Mr. Chatsworth, as it filtered through his forgetful mind why his wife had inquired so pointedly as to the date. And he seemed so pleased with the new acquisition that Mrs. Chatsworth immediately forgave him for his forgetfulness.

"BUT what put the idea into your head?" asked Mr. Chatsworth, after he had opened all the doors and inspected the refrigerator critically.

"When I was paying last month's light bill they were demonstrating it in the Company's show room. One of the salesmen nailed me, and I guess it wasn't hard to get me to sign on the dotted line. It'll be such a comfort, and so easy to pay for. I arranged to have $20 a month charged on our light bill."

"The electric light company is certainly on the job these days," observed Mr. Chatsworth. "One of their men has been calling at our plant quite a lot lately. He has sold our chief engineer on adding quite a bit of electric equipment in our finishing department."

* * *

This simple bit of domestic conversation we reproduce because it illustrates a vast movement that is going on throughout the public utility industry, a movement especially significant to the investor.

On September 4, 1882, the first power and light central station began business with just 59 customers. It was hard going at the outset. Some of the early customers were given free service for a few months as the only way to break down their skepticism. But once the idea took hold and people began to realize its convenience the number of commercial, industrial and domestic customers of light and power companies grew by leaps and bounds.

By 1922, only forty years after the first central station was established, over forty-three millions of our population were living in electrically wired homes; over two million commercial establishments and nearly half a million industrial plants were public utility customers. (Today these figures are much higher.)

This rapid growth gave the utilities something else to worry over. It looked as though the saturation point was near at hand. They were gravely concerned over their ability to keep up the pace of growth and development.

> ## A Service for Readers
>
> **THIS Financial Department is to help readers in the establishment of proper financial programs at the beginning of their business careers; it assists those who have accumulated money in the proper investment of it.**
>
> **The Editor of this Department is an authority on investment matters. He is ready to aid in personal investment problems. Advice will be gladly given regarding the proper investment of funds and proper plans of saving.**
>
> **Address your inquiries to Wallace Ames, Financial Editor, POPULAR SCIENCE MONTHLY, 250 Fourth Avenue, New York. While investments obviously cannot be guaranteed by the Publisher, every effort will be made to insure that only advertisements of absolutely reliable companies are accepted.**

IN 1926 *Electrical World* conducted a thorough survey of the light and power situation. This study dealt with the present status of electrification and determined the full possibilities of developing additional business among customers then existing. The results, when carefully tabulated, analyzed and cross-checked, showed that the market then available was only one-tenth developed. That is to say, without adding a new customer, but simply selling present customers the idea of complete electrification and full use of electric service, there was a potential volume nine times as great as the amount of business already being done.

The whole subject was the leading topic of discussion at (*Continued on page 5*)

Mrs. Chatsworth *Increases the Value of* Public Utility Shares

(Continued from page 4)

the 1926 Convention of the National Electric Light Association. The key to the situation was shown to be the relation of rate to volume. It was found that a lower kw. rate was essential to induce a more complete use of electrical service. On the other hand the study revealed that the larger volume would permit the lower rate at a profit.

In 1926 domestic customers were consuming an average of 365 kw.-hr. per year. The average rate was 7.64c and the average annual bill $27.89. A well-applianced home, using an electric range, refrigerator, water heater, vacuum cleaner, washer, etc., could use between 4,000 and 6,000 kw.-hr. annually. At an average rate of 3.59c (as compared to 7.64c) the average annual household bill would be $202.88 (as compared to $27.89.)

The study not only delved into the possibilities of building domestic business, but also covered rural service, commercial lighting, industrial power, industrial heating, commercial cooking, railroads, railways and miscellaneous fields. The entire survey brought to light these facts:

If possibilities were fully realized, the yearly sale of electric energy would increase from 47,997,000,000 kw.-hr. to 299,400,000,000 kw.-hr. Calculated on the basis of the reduced rate, combined gross income of all central stations would increase from $1,470,000,000 annually to $7,211,817,480.

The generator capacity to handle this volume would have to be increased from 26,830,000 kva. to 62,300,000 kva. This would require a capital investment of $21,805,000,000 as compared to the 1926 figures of $7,500,000,000.

Doing the larger volume of business the average load factor would increase from 34.2% to 76.8%. The investment per kilowatt would increase from $290 to $350 while the income per kilowatt capacity would jump from $54.78 to $115.76. The ratio of capital to income would decrease from 5.1/1 to 3.1/1.

If these statistics seem a bit confusing they nevertheless establish the truth that if utilities sell the idea of complete electrification, offer the rate necessary to get the volume and invest the amount necessary to provide the increased service, they could keep their plants more continually busy, make more money and turn over their capital more frequently. To revert again to the average household it would spend seven or eight times as much for electricity and get fifteen times as much service. Even on the higher basis of, say, $17 a month, how else could such a moderate sum purchase so much in comfort and convenience?

THUS it came about that public utilities became selling organizations as a matter of administrative policy. Until recent years their chief effort had been devoted to getting ready to serve. With the major portion of the country wired for electricity the utilities are now exerting every effort to sell full (Continued on page 6)

Mrs. Chatsworth *Increases the Value of* Public Utility Shares

(Continued from page 4)

service to each customer. You now see attractive show rooms filled with electrical appliances, salesmen from the local lighting company call at your home to sell washers, refrigerators, vacuum cleaners, etc. Appealing circulars are enclosed with your bills. Similarly the industrial and commercial fields are being covered. The utility today is a selling organization.

This, then, is one of the many pictures of the investment status of public utility companies. It shows why they must raise money through the sale of bonds and shares. It shows how investment in them is protected as to both principal and income.

To Help You Get Ahead

THE Booklets listed below will help every family in laying out a financial plan. They will be sent on request.

"The Investment Trust from the Investor's Viewpoint," presents an explanation of this form of investment in easily understood terms, illustrated with some interesting examples of how the general investment trust will help the man with $100 or more to get ahead. Published for free distribution by United States Fiscal Corporation, 50 Broadway, New York. Ask them for Booklet IT.

"Ideal Investments" is the designation universally accorded Smith First Mortgage 6½% Bonds which carry attractive tax refund features. A history of the House and information relative to their bonds and the safeguards that surround every issue they offer may be obtained by addressing the home office of The F. H. Smith Company, Smith Building, Washington, D. C.

The House Behind the Bonds reminds the investor of the importance, not only of studying the investment, but of checking up the banker who offers it. Address: Fidelity Bond & Mortgage Co., 1188 New York Life Building, Chicago, Ill.

How to Retire in Fifteen Years is the story of a safe, sure and definite method of establishing an estate and building an independent income which will support you the rest of your life on the basis of your present living budget. Write for the booklet to Cochran & McCluer Company, 46 North Dearborn St., Chicago, Ill.

How to Get the Things You Want tells how you can use insurance as an active part of your program for getting ahead financially. Phoenix Mutual Life Insurance Company, 318 Elm Street, Hartford, Conn., will send you this booklet on request.

The Guaranteed Way to Financial Independence tells how a definite monthly savings plan will bring you financial independence. Write for this booklet to Investors Syndicate, 100 North Seventh Street, Minneapolis, Minn.

The Making of a Good Investment tells how 6½% can be made on investment in First Mortgage Bonds in units of $50, $100, $250, $500 and $1000; how the bonds are protected and how simple it is to purchase them. For a copy of this booklet address United States Mortgage Bond Company, Limited, Detroit, Michigan.

"Always the Same," Says Pipe-smoker of This Tobacco

A tobacco that keeps a pipe-smoker contented for five years apparently has something about it of interest to the great pipe-smoking fraternity.

And so it is with pleasure that we reproduce a letter from Mr. Beatty of South Carolina, who reserved his opinion of Edgeworth for five years—and then spoke up.

Charleston, S. C.,
February 10, 1927

Larus & Bro. Co.,
Richmond, Va.

Gentlemen:

I've done a lot of pipe smoking. There's hardly a brand or a blend that I haven't tried out at some time or other.

But speaking of smoking tobacco that brings real enjoyment and never changes, I want to say that there is just one tobacco that gives me real enjoyment in my pipe—Edgeworth.

I have used Edgeworth Ready Rubbed and Plug Slice for over five years, in all climates and under all conditions, and I find it always the same. It is always mellow and moist, and its genuine flavor lasts. There is no bite or parch in Edgeworth, and the quality, whether you buy it in small or large quantities, is always perfect.

Thanks to the manufacturers for their wonderful product, and I hope that Edgeworth can always be obtainable by the undersigned.

Guy B. Beatty

That's the way Edgeworth is—it seems to keep smokers contented, and sooner or later they write in to tell about it.

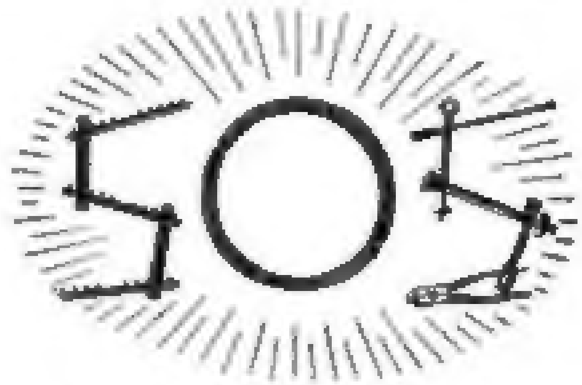
To those who have never tried Edgeworth, we make this offer:

Let us send you free samples of Edgeworth so that you may put it to the pipe test. If you like the samples, you'll like Edgeworth wherever and whenever you buy it, for it never changes in quality.

Write your name and address to Larus & Brother Company, 10 S. 21st Street, Richmond, Va.

Edgeworth is sold in various sizes to suit the needs and means of all purchasers. Both Edgeworth Plug Slice and Edgeworth Ready-Rubbed are packed in small, pocket-size packages, in handsome humidors holding a pound, and also in several handy in-between sizes.

[On your radio—tune in on WRVA, Richmond, Va.—the Edgeworth Station. Wave length 254.1 meters. Frequency 1180 kilocycles]



—a signal with a double meaning

S.O.S.—flashed from out of some sea disaster sends its tragic appeal to "Save Our Souls."

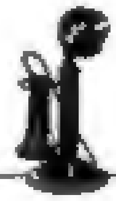
S.O.S.—in France with Pershing these letters meant a prompt and thorough Service of Supply, backing up the front lines.

Here in America today the business of telephone manufacture and distribution too has its S.O.S.—the prompt service of supply with which Western Electric backs up the nation's telephone companies.

The emergencies, when fires, floods and storms threaten to cripple telephone service, are a part of the day's work, and are anticipated and provided for—by previous planning in building up reserves of equipment in a nation-wide chain of 33 distributing houses.

And then there is the greater, though less spectacular, every-day job of providing the sinews of telephone service for the nation—a service of supply challenging comparison in efficiency and cost.

Thus as distributors, and also as manufacturers and purchasers for the Bell System, Western Electric finds its adventures in many fields. All to serve you when you raise your receiver off the hook!



Western Electric

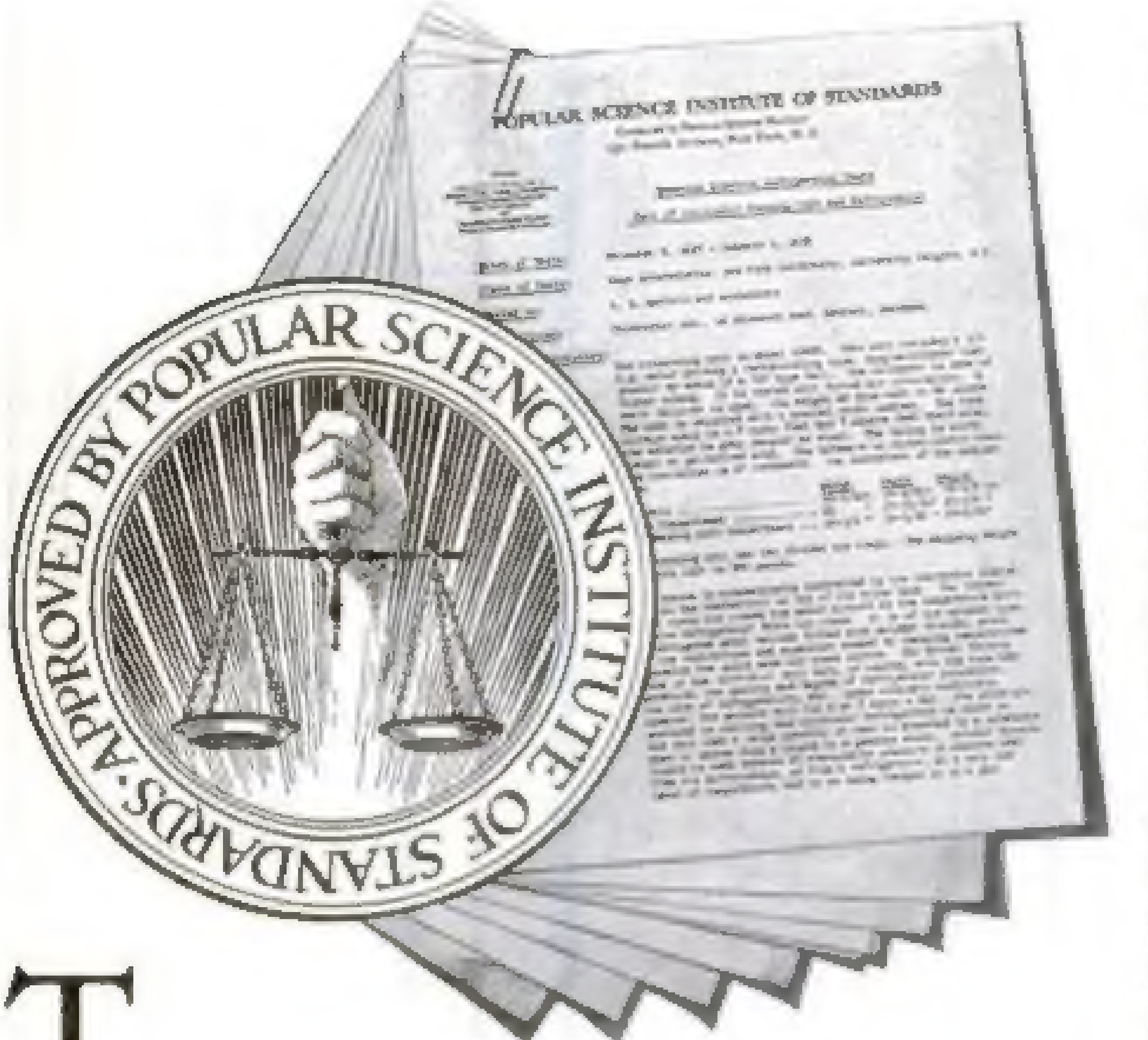
Purchasers... Manufacturers... Distributors

SINCE 1882 FOR THE BELL SYSTEM

An Organization That Is Ready to Tell You

What You Want to Know

About Refrigerators . . Tools . . Oil Burners . . Radio



THE things we buy daily, monthly, or yearly are ones which, as a rule, we need no outside help in purchasing. But when it comes to buying something that only has to be bought once or twice in a lifetime, there is not much in the way of past experience to guide us. In such instances it becomes necessary to do a little investigating if a wise selection is to be made.

With most of us, this investigation process is necessarily limited. We ask those of our friends who have had experience with equipment of the type, question salesmen, and generally try to find out what is what. The trouble with such an investigation is that it seldom goes far enough or is sufficiently impartial; the experience of friends is restricted to comparatively few makes and salesmen's advice is rarely unprejudiced.

If the product you are buying is one that will last some time and requires a considerable investment, it is worth while to look for further guidance. In this connection, you will find the advice of some of the reliable testing organizations now in operation helpful inasmuch as their experience is thorough and covers a large number of the products in a field.

When selecting refrigerators, oil heating equipment, radio apparatus or tools, you will find the Popular Science Institute of Standards ready with a very comprehensive and impartial service—a service that is based on data which no individual could collect.

At its disposal the Popular Science Institute of Standards has $150,000 worth of testing equipment in the Sage Engineering Laboratories at New York University, where the tests are made.

THERE is not a product approved by the Popular Science Institute of Standards without Dean Bliss' sanction; he personally goes over with the engineer in charge of tests the report on every product and determines whether approval is merited. To receive the approval of the Popular Science Institute, equipment must be so designed and constructed that it will give efficient and lasting service; it also must represent good value, since price as well as performance is considered.

The tests that determine these facts are necessarily extensive—just how extensive few people realize. For example, the other day a letter was received from a reader of POPULAR SCIENCE MONTHLY who wanted to know what tests The Institute put refrigerators through as he would "like to try them on his own refrigerator in his home."

This reader did not realize that it took the Popular Science Institute several months and as many thousands of dollars to construct a constant temperature room necessary for the accurate testing of refrigerators. He was not aware that the all-inclusive tests made on a refrigerator take at least a month, with temperatures being recorded every hour of the night and day by most ingenious devices. And he also failed to take into consideration that it requires electrical and engineering experts of the highest type to make such tests.

AS AN indication of the high value placed on The Institute's tests by authorities in a position to appreciate their nature, we cite the recent appointment of the Popular Science Institute's Director, Dean Bliss, as a consulting mechanical engineer to the U. S. Bureau of Standards in Washington. Ever since The Institute's establishment four years ago, Government officials have been in close touch with it, visiting the laboratory and witnessing tests in progress.

Readers of POPULAR SCIENCE MONTHLY therefore may place full confidence in products bearing the seal of approval of The Institute. Special inquiries on radio, tool, oil heating, and refrigerating equipment and requests for lists of approved makes should be addressed to the Popular Science Institute, 250 Fourth Ave., New York, N.Y.

Popular Science Monthly
GUARANTEE

The above seal on an advertisement indicates that the products referred to have been approved after test by the Popular Science Institute of Standards.

POPULAR SCIENCE MONTHLY guarantees every article of merchandise advertised in its columns. Readers who buy products advertised in POPULAR SCIENCE MONTHLY may expect them to give absolute satisfaction under normal and proper use. Our readers in buying these products are guaranteed this satisfaction by POPULAR SCIENCE MONTHLY. THE PUBLISHERS

This *grainless* wood board is writing a new page in the drama of progress!

Possesses remarkable workability—won't crack or split. Revolutionizing methods of manufacturing in many industries. New uses discovered almost every week. Send for large free sample and find out what Masonite Presdwood will do for you.

FOR SIGN BOARDS

Here is a creation of modern inventive genius that is challenging the imagination of manufacturers in scores of industries, and that has already made it possible for a number of them to reduce their operating costs, improve their products and broaden their markets.

A genuine all-wood board which is absolutely *grainless!* A board that positively will not crack, check, split or splinter. A board of uniform strength and truly remarkable workability!——That, briefly, describes Masonite Presdwood.

And yet these are only a few of the many advantages of Presdwood. It is very dense and tough. It is highly resistive to moisture. It has a smooth, attractive surface on the face side, requires no paint for protection, and takes any finish beautifully.

Can be cut and milled

Presdwood is simply wood torn apart and put together again. It contains no foreign substance; not even a chemical binder. So it cannot damage tools.

Presdwood comes in a four-foot by twelve-foot size. It can be used on any woodworking machinery. It can be cut out, punched, die cut and milled. In fact, Presdwood is adaptable and workable almost beyond belief.

From doll houses to bridges!

There seems to be practically no limit to the uses for Presdwood, and new uses are being discovered week after week.

Candy makers are now using Presdwood for starch trays, and in the Chicago Art Institute it is backing and protecting rare works of art.

Store fixtures of many kinds, incubators, clothes hampers, bedroom screens and fire screens are made of Presdwood; so are work-bench tops, bread boxes and concrete forms.

You will find Presdwood as paneling in the new Pullman cars of several leading railroads; you will find it made into tension boards for many radio speakers. Large halls and pavilions have floors of Presdwood; and it is already beginning to go into fine office buildings, apartment buildings and homes for the same purpose.

FOR SAFETY WHEELS

Toys are made of Presdwood; trunks, wardrobes, bank vaults, and telephone booths are lined with it.

There are kitchen cabinets, shelving, and office partitions of Presdwood; thousands of feet of it are used in making movies; there is now a demand for it in the construction of dams.

In brief, Presdwood uses range from doll houses and invalid trays to bridges and flumes!

Withstands the wear of all outdoors

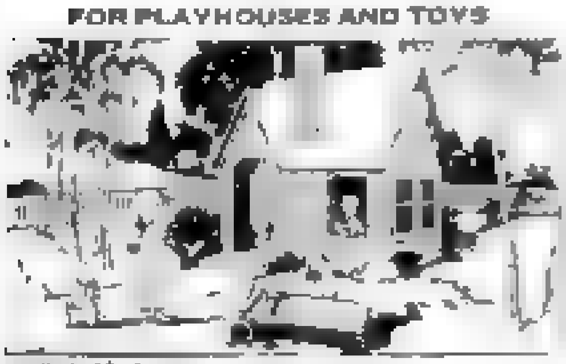
Out in the open country—there, too, Presdwood is proving what an enduring, adaptable material it really is. Water, wind and scorching sun have little effect upon it, even when it is left unpainted. Steadily, persistently, it withstands wear and tear that have wrecked many another material in a comparatively short time.

Presdwood is being used for speed boats—alike on the Gulf of Mexico and the lakes of Wisconsin. Campers' tables are made of Presdwood; so too are safety wheels for bathing beaches, and particularly signs—all kinds of signs. Holstein and Guernsey Breeders, for example, are using Presdwood sign-boards in Wisconsin, Minnesota, Iowa, Nebraska, the Dakotas, and as far west as Idaho.

And so the list of Presdwood uses might be continued for many paragraphs. We suggest that you put this *grainless* all-wood board to the test yourself. It may be exactly the material you are looking for. Write today for large free sample. It will be sent promptly on request.

MASONITE CORPORATION
Sales Offices: Dept. 1288 111 W. Washington St.
Chicago, Illinois

FOR PLAYHOUSES AND TOYS

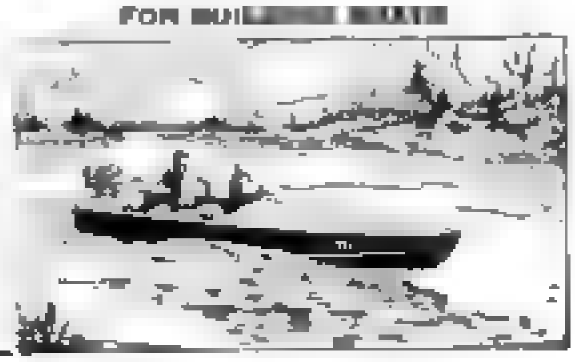


Mills, Laurel, Mississippi

Masonite PRESDWOOD

Made by the makers of
MASONITE STRUCTURAL INSULATION

FOR BUI[illegible]



1928 M. F. Co.

Our Readers Say—

The Long and Short of It

"I THINK there should be more leading articles in your magazine and fewer short paragraphs containing inventions that are not of interest to the average reader."—D. M., Philadelphia, Pa.

"I am an enthusiastic reader of POPULAR SCIENCE MONTHLY because I feel that it keeps me posted on all the new discoveries and inventions."—R. P., Trenton, Tenn.

"I am under the impression that your magazine is improving with age. I am simply astounded to note the unlimited variety of long and short articles that are published every month."—G. A. S., Porterville, Calif.

One Surprised Thief!

"FOLLOWING the instructions in your 'Kinks for the Motorist,' I put on my car that knife switch which sounds the horn if a thief tries to monkey with the ignition switch. Last Saturday afternoon I left my car on a block in the civic center, and by mistake left my keys in the ignition switch. As usual, I threw the antitheft switch on and left the car.

"The office I went into looked right down on the car where I had it parked. While I was talking we suddenly heard a horn blowing. I knew it was my car. Sure enough, I saw a man get out of it and walk away. He had the most surprised look on his face I ever saw. A policeman walked up to him and asked what all the horn blowing was about. The thief didn't give a satisfactory answer, so the cop called a patrol and took him to the station. The funny part was that when I went down to the car, there was a mechanic trying to shut the horn off, but he couldn't do it. The sap didn't think to turn the ignition key off."—P. H. P., Providence, R. I.

Why Not Buy Another Copy?

"I WANT to tell you how your monthly is appreciated over here. We have a copy in the library but there is such a demand for it that it is only by strategy that I have ever been able to get at it at all. Reading your magazine has given me an idea of what Americans do, think, and wish to do. It has made me interested in American progress and science."—A. G., Egremont, England.

Can a Plane Fly Backwards?

"ON PAGE fifty-three of your June issue you have an article concerning a variable pitch airplane propeller. The claim is made by the inventor that a ship 'could even fly backwards' with the device. This is absurd in the extreme. Anyone with the slightest bit of intelligence knows that flight is made possible by the forward motion of a system of airfoils bearing a very definite and essential angular relation to each other and to the direction of motion. Move the system backwards and you reverse every function. It is true that a stalled ship will fall back on its tail after being pulled up into a sharp stall, but the outcome of the maneuver as a spin or a resumption of normal flight depends more on the correct placing of the center of gravity and the rigging of the ship than upon the functioning of the control surfaces during reversed progression."—F. J. S., Los Angeles, Calif.

Puts Science in Its Place

"SOME ignorant boob, on page thirty-eight of your June number, says that one Galileo disproved the theory that weight determines speed of falling bodies. This writer is ignorant, likewise all scientists, for a ball of lead will fall with a greater speed through space than a ball of wood, having the two balls the same in their largeness of size. This I have proved as a fact, and, unless you ignorant fools come to me and learn facts, and stop fooling the public, I will soon put scientists to shame."—C. E. B., Asheville, N. C.

Another Vote for Elinor

"I CAN fully sympathize with J. E. N., and agree with his letter in your June issue that 'Elinor Was Right.' I attended school in six different states, have lived in twenty others, lived nearly four years in India and traveled in twenty-five other countries. I have devoted all my spare time to studying good books; have read the Koran and studied various complete histories of the world. Can converse to some extent in geology, astronomy, physics, mechanics, evolution, the fourth dimension. I know algebra, geometry, trigonometry, logarithms and understand the slide rule. I have worked with mechanical appliances and inventions all my life. Riding, polo, boxing, shooting have been my hobbies. I have hunted big game and owned and trained various kinds of animals. And, as hard as I have tried, I have never been able to interest anybody with my talk. One has got to have 'It.'"—J. D. R., Pittsburgh, Pa.

What's Your Figure?

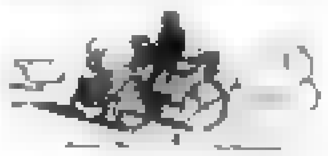
"WHEN you put on a contest, why do you print the poorest answers? You had me interested in that contest of helping Gus and his friend in picking out a car. But when you printed the prize-winning answers, I was disgusted. I know that out of the sixteen, only two were at all correct. You head them 'One Hundred and Sixty Dollars Worth of Advice.' I would change it to: 'One Hundred and Sixty Dollars Worth of Boloney.'"—H. G. S., Arcadia, Fla.

Killing Time in Canada

"IF YOU can't publish your magazine every week, you shouldn't publish it at all. How do you expect a man living 2,000 miles out in the wilds of Canada to wait thirty days for each copy? It means a week's careful reading, a week's cogitation on the contents, and then two barren weeks waiting for the next issue."—W. S. P., Semans, Sask., Canada.

When Old Is New

"IN YOUR issue of June two new (?) ideas have blossomed forth. First idea—'New Gear-Shift Propeller.' This may be new for airplanes, but the same idea was used years ago in river speed boats. Next new (?) idea: 'No Gear Shift in New Auto.' Some fifteen years ago automobiles and trucks ran in Pittsburgh with this identical idea. On the trucks each of the four wheels had a motor. On autos, one motor was all that was employed. To us old fellows a lot of these ideas are a rehash."—W. F. P., Pittsburgh, Pa.



Our Art Critics Say—

"I HAVE worked side by side with a big magnet like the one shown on the cover of your June number. You've got the idea, all right. Those brutes sure can lift."—A. N., Pittsburgh, Pa.

"I want to say that your recent cover paintings have been about the most colorful and vigorous pieces I have ever seen. I am no art expert, but I think that you and your artist have done something quite distinctive in interpreting the true spirit of American enterprise."—Dr. S. A. B., Minneapolis, Minn.

Why Editors Grow Bald

"THE thing I do not like about your magazine is the section with all the useless matter on aviation."—M. G., Chicago, Ill.

"Will you permit me to compliment you upon the vivid and complete way in which you are reporting the important events in aviation each month? It is the most interesting part of your magazine."—E. A. T., New York City.

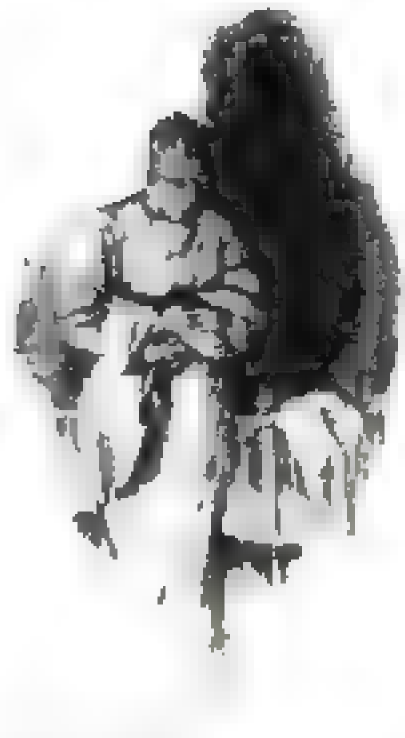
Here's to Dick Byrd!

"COMMANDER RICHARD E. BYRD, gentleman, explorer and scientist, should not be criticized unjustly by anyone. Who is there in the position to say that his flights were foolhardy? He proved there was no land in the polar regions, and demonstrated the accuracy with which navigation instruments can be used. As for Byrd risking the college boys' lives, remember these boys volunteered and had to have the permission of their parents. If, as A. L. M. said in his letter, Byrd's flight to the South Pole is foolhardy, why are some of the country's greatest scientists offering their services?"—S. H. J., Brockton, Mass.

Why an Icebox?

"I WAS particularly interested in the letter of G. H. T. of Philadelphia, who contended that the purpose of a refrigerator is not to kill putrefactive bacteria in food. Why, then, G. H. T., have you an icebox in your home, if you think it is merely a convenient place to put foodstuffs? You might as well put your eggs, roast meat, corn, cheese, milk, bacon, and butter on a shelf. I agree with G. J. Z. of New York, that the investigation of the household icebox is very important."—W. J. M., Sarasota, Fla.

CROWDED DAYS The jangle of telephones, a sea of papers on your desk, a stampede of interruptions — and the day is over before you've accomplished all you intended to. Night after night you go home really tired — with nerves perhaps a bit on edge. Then your Gillette Blade has a double job to do in the morning — but it must give you the same easy comfort that you get on more leisurely days.



RESTLESS NIGHTS Those A. M. tours of the house with a wakeful child never soothed anyone's tired nerves. A few short hours of sleep when you want about ten of them — and the alarm brings you face to face with your razor. Then — comfort! The smooth, steady, unchanging comfort that's a family characteristic of all Gillette Blades!

HECTIC MORNINGS A trifle unsteady — even the brightest dawn looks grey. But in your razor is a fresh, even-tempered Gillette Blade. It's the one constant thing about your daily shave. You can always count on its smooth, sure comfort, no matter how ruffled your nerves.

Jumpy nerves

can't take the smooth, sure shave out of the Gillette Blade

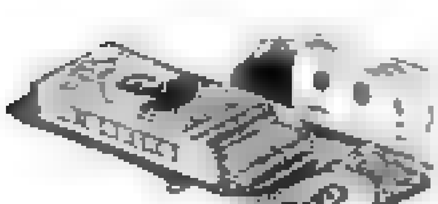
WORRY—a sleepless night behind you and a stiff day ahead—have you ever noticed how your skin tightens on such mornings—how different and more difficult even a simple thing like shaving seems to be?

Relax. Lather well and give the soap and water time to soften your beard before you start to shave. One thing you can always count on: your Gillette Blade—every Gillette Blade—will be right up to its smooth, even job, no matter how jumpy your nerves may be on any particular morning.

Gillette makes this promise to every one of the 28,000,000 Gillette users in America. To keep it we have spent, during the last ten years, millions of dollars for blade improvements alone — 500 patents, embodied in machine processes that are accurate to one ten-thousandth of an inch and timed to one one-thousandth of a second; a factory system that makes four out of every nine workers inspectors, and nothing else, and pays a bonus for detecting every single blade that won't do a superb job of shaving.

All this, so that *every* Gillette Blade may play its smooth, even-tempered part in your daily shave, every morning.

GILLETTE SAFETY RAZOR CO., BOSTON, U. S. A.



To be sure of a smooth, comfortable shave under any conditions, slip a fresh Gillette Blade in your razor.

Gillette

Gillette

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Popular Science MONTHLY

AUGUST, 1928 SUMNER BLOSSOM *Editor* VOL. 113, NO. 2

What Can Happen While You Wink Your Eye

Study this picture. It will show you why accidents happen. It takes only about one-tenth of a second for a wink of an eye, and in that time we can travel the approximate distances indicated. Yet after seeing danger ahead it takes about a second for our muscles, acting on orders from the brain, to respond to the emergency.

By
E. E. FREE

A FEW years ago, when kings were more plentiful than now and more apt to be knifed or shot, soldiers used to keep clear a space around each royal person, a kind of safety zone within which no intending assassin could penetrate and where uneasy crowned heads could feel reasonably secure.

Each human being, whether he knows it or not, goes through life surrounded by just such a neutral zone, a space within which men, automobiles, or other objects may be extremely dangerous, beyond which they are safe. For some people this sphere of safety is narrow, for others it is wide. Its actual width for you is fixed by how long it takes you to think.

Consider, for example, the all-too-frequent automobile collision. Tests of fifty-seven typical drivers made by the U. S. Bureau of Standards showed that the average time needed to see a danger signal, realize its meaning, and begin to press the brake lever was a little more than half a second. In this time a car traveling at forty miles an hour would move thirty feet. That is the minimum width of the driver's zone of safety. But some persons need more time than this; they do not begin to press the brake lever until a full second or even two seconds after the danger signal has appeared. Cars driven by such slowly reacting individuals would travel, respectively, sixty feet or a hundred and twenty feet, not merely before the car could be stopped, but before the driver even began to bring it to a stop! In other words, the surrounding zone which such slow-thinking persons must keep clear to avoid disaster is necessarily two or even four times as wide as that of the average driver.

Professor Charles F. Park of the Massachusetts Institute of Technology, expert on automobile traffic, recently emphasized this viewpoint of the ever-growing problem of how to keep people from being killed on streets and highways. Last year 40,891 persons were killed and nearly 800,000 injured in automobile accidents. Since 1921, more than 3,500,000 people have been injured and more than 100,000 killed by automobiles in the United States, while money losses have been more than $3,000,000,000. Every public official concerned with this appalling situation realizes, Professor Park emphasizes, that something must be done.

"There has been a return," he says, "of the speed craze." Manufacturers are advertising faster cars. People will buy these cars. Average highway speeds are increasing. Sixty-nine percent of the highway accidents in Massachusetts last year, Professor Park computes, were due to speed "too fast for existing conditions and the kind of driver."

THAT last phrase is the very core of the problem. It is the explanation of the idea of a necessary zone of safety which each person must manage to

maintain at peril of injury or death.

Few motorists know, the Massachusetts expert argues, the one most important thing about themselves—that is, the characteristic which psychologists call the "reaction time." It is this that measures the width of the safety zone which you must guard, as soldiers guard the open space around a king.

Suppose you were driving the automobile in the right foreground. What would you do? From the opposite side of a car which has just crossed your path looms an approaching taxicab. Traveling at thirty miles an hour, if you continue straight ahead, a crash is inevitable. On one side are pedestrians, a baby carriage; on the other, a car full of passengers. What would be your decision for the least possible damage to life and property?

NOT long ago a young man of more than average intelligence and driving skill was arrested for speeding and haled before a magistrate in New York City. It was his third offense.

"I know I was speeding," he confessed, "and I know I was taking chances—But, Your Honor, I have a high-powered car, and I simply can't help it! The only way to stop me, I guess, is to revoke my license."

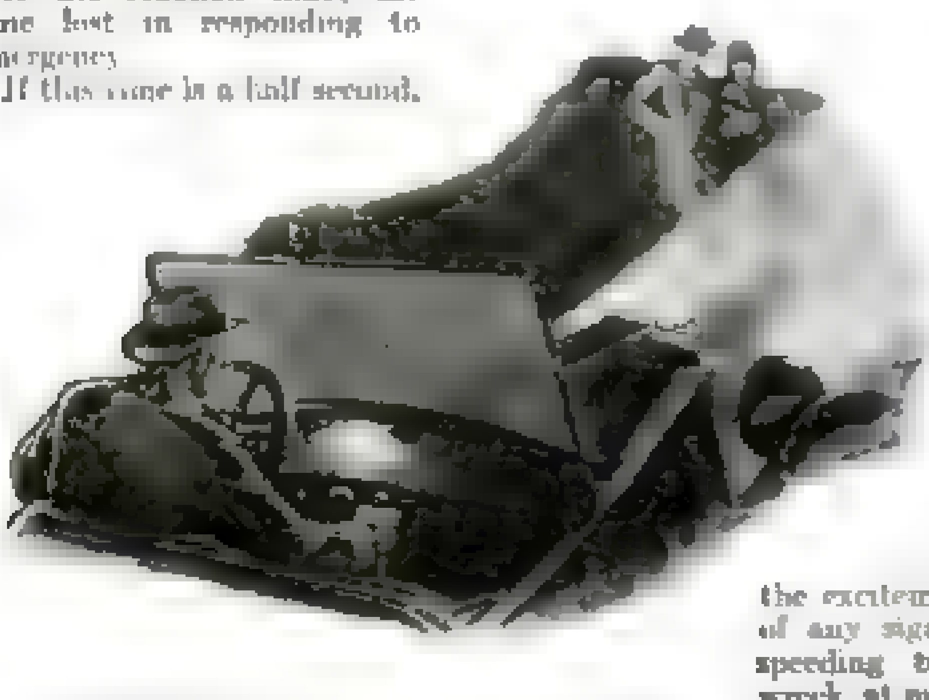
The judge followed his suggestion.

The menace of slow-thinking drivers on the highways is impossible to compute. No one can say how many thousand lives, how many millions of money, they have cost themselves and others in the last ten years; not because they are careless or incompetent, but because their thinking machinery does not work fast enough to keep up with modern mechanical speeds.

IT TAKES a fraction of a second for a sight to register on the sensitive retina of the eye, or for a sound to affect the mechanism of the ear. Then another fraction of a second is lost in transmitting the sight message or sound message over the proper nerve to the thinking cells of the brain. These thinking cells lose a few more precious second-fractions while they decide what needs to be done; settle, for example, upon the idea that the foot brake of an automobile needs to be pressed. Still another hundredth of a second or so is lost while the necessary orders are prepared to go to the muscles that must do the work. Then another brief time is used in sending the message down the nerve to the muscle, and finally there is a trifle of delay while the muscle gets ready to act. All these delays, added together, constitute the reaction time; the time lost in responding to emergency.

If this time is a half second, the average of the drivers tested by the Bureau of Standards, the driver, running at forty miles an hour, is highly dangerous to himself and everybody else within thirty feet. If anything shows up suddenly twenty-five feet in front of him he will hit it. No escape is possible, for he cannot complete his thinking process in time to make the necessary motions.

IF THE speed is sixty miles an hour the needed safety zone is correspondingly wider. If the driver's reaction time is longer, the zone is wider still. Practically nobody can react to such a danger in less than three-tenths of a second. Most modern automobiles can travel sixty miles an hour, and most of them are tried out, occasionally, at this or higher speed. A simple calculation based on an average speed of about twenty miles an hour, shows, therefore, that every automobile ought to be preceded by at least twenty-seven feet of clear space. That much is necessary to enable the driver to think.



Pedestrians at night can best safeguard themselves from being hit by wearing light-colored clothing, which is seen most readily by automobile drivers.

On November 25, 1923, the famous racing driver Harry Hartz, was making a practice spin on the automobile speedway at Beverly Hills, California. While he was on the back stretch of the track, another car caught fire in front of the grand stand, near the mechanics' pit. In the excitement no one thought of any signal to warn Hartz, speeding toward the blazing wreck, at more than two miles a minute. For him to have swerved to one side would have smashed a dozen cars and drivers, waiting to go on the track for the next event. To have swerved in the reverse direction would have thrown his car into the crowded stands. Either way would have cost dozens of lives.

Hartz did the right thing. He kept straight on, hit the blazing wreck at full speed, was catapulted from his own car across the track and into the pits, escaping death by a miracle. Two men standing by the blazing car were killed, but the loss of life was probably the least it could possibly have been.

Hartz was complimented on his decision, and rightly so, for that is doubtless the decision that he did make and would have carried out had there been time. And yet it is extremely doubtful if his decision ever was effective. An automobile speeding at 120 miles an hour moves nearly two hundred feet in a second. For the average driver its zone of safety cannot be less than a hundred feet. How far away Hartz was from the wreck when he saw it is uncertain, but quite probably he was too close to do anything at all. Even had his decision been to try to avoid the smash and risk a greater one, he probably would have hit the wreck just the same. His nerves and brain cells would not have had time to begin to twist the steering wheel!

THE fastest thing that any man can do is to wink his eye. The instinctive reaction of winking when a cinder blows into the eye is about one-tenth of a second for most people. In that flash of time, an automobile speeding sixty miles an hour will move nearly ten feet. A fast airplane will move more than twenty-five feet. An airplane pilot can run into a small bird, for example, after he can first see it and before he has time to wink his eye against the expected shock. A golf ball, driven at the wrong angle, can hit a man fifteen feet away before he winks. A rifle bullet will travel three hundred feet. A

meteor or "shooting star" will move between one and two miles. If a meteor's path is toward you it will do no good to dodge. Even if you sight it two miles off it will hit you before you can wink.

FOR practical purposes, however, the extremely quick reaction of an eyewink is not what needs to be taken into account. If accidents are to be prevented some means must be devised, as Professor Park insists, either to quicken human responses until they fit out new machinery or else to slow up automobiles and other machines until they fit the reaction time of the average man or woman. Many experiments by psychologists on hundreds of thousands of persons prove that this reaction time for the general population cannot safely be taken as less than one second.

This time of one second fixes, therefore, the zones of safety which should surround all kinds of machines.

For the average automobile speed of thirty miles an hour the safe distance is forty-five feet. For sixty miles an hour it is ninety feet. If your steering mechanism breaks at a sixty-mile speed you will have been hurled nearly ninety feet farther before you have time to act. For racing cars at two hundred miles an hour, the distance needed for thinking is 300 feet.

FOR railway trains at the speeds of sixty or seventy miles an hour, the safe thinking distance of the engineer is no larger than for automobiles, although it may take longer to bring his heavier mechanism to a halt. In a recent railway wreck in Germany it was proved that the engineer had fallen asleep and allowed his train to run too rapidly over dangerous track. The conductor, who should have pulled an emergency brake, claimed that the twenty-two seconds which elapsed between the failure of the engineer to slow up and the resulting wreck was not enough time for this thought process to operate.

By advice of Professor Karl Marbe, noted psychologist, the defense was denied. Four seconds was sufficient, he decided, for any possible combination of the necessary thought processes on the part of a reasonably alert conductor.

A motor boat, at the record speed of seventy miles an hour, needs a safe radius of 105 feet. Airplanes are about the same as racing automobiles, the speeds attained being of the same order. If Max Valier and Fritz Opel ever succeed in perfecting their proposed rocket airplane, to be shot from Europe to America at an average speed of a thousand miles an hour, the necessary zone of safety for that craft will be nearly a quarter of a mile!

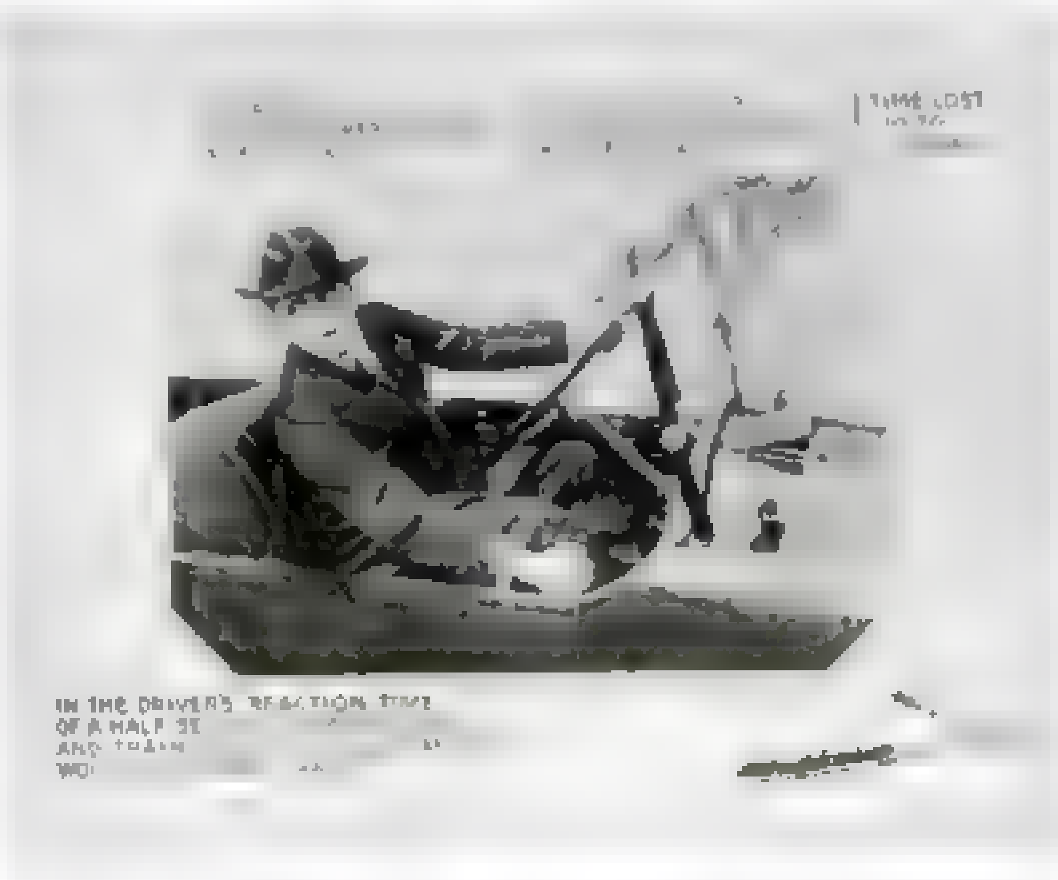
This idea of a zone of safety determined jointly by speed and by human reaction times applies, of course, to the people who are hit by the speeding object as much as it does to the speed demon itself. A short time ago, a baseball was dropped off the Washington Monument. A player on the ground managed to catch it. Calculation indicates that the ball was probably moving about 125 feet a second when it was caught. Pitched balls sometimes move almost as fast, batted ones move more slowly. Probably the average foul tip, just off the batter's bat into the grandstand, is moving about fifty or seventy-five feet a second. For a person whose reaction time is one second, and who sees such a ball only fifty feet away from his head, there is no hope. He will just about have time to close his eyes but not to dodge.

There are applications of the idea to human movements also. A man walking at a brisk rate of four miles an hour has a safety zone of six feet. If a manhole suddenly opens three feet in front of him he will fall in. The distance is too short to give him time to see the danger and avoid it. For a marathon runner making ten miles an hour, the safe thinking distance is fifteen feet. For a sprinter going as fast as Paddock did when he made his nine-and-a-half-second record in the hundred-yard dash, the zone of safety in front must be lengthened to approximately thirty-one feet.

Sprinters who are racing toward each other at ten yards a second are bound to collide if they sight each other when only thirty feet apart.

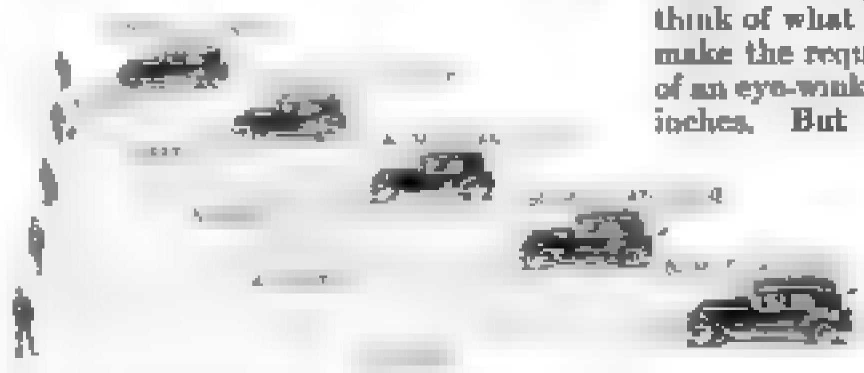
FOR two runners approaching collision the safe distance equals their mutual speed divided by their average reaction time. Two Paddocks, for example, sprinting toward each other, will collide inevitably if they turn a corner and catch sight of each other when only thirty feet or so apart. That assumes an average reaction time of one-half second each.

This considerable time that people need to think also explains the mystery of why so many suffer falls, when it seems that they might easily save themselves by grabbing some near-by support. Among 22,555 home and street accidents reported by policy holders of the Travelers Insurance Company in 1927, 4,524 consisted of falls. Seventy-three of these were falls into bed and out of it and sixty-four were falls out of bathtubs. Certainly something must have been at hand to take hold of in most of these instances.



In emergency, as when an auto and train approach each other in the positions shown at the lower right, precious fractions of a second are lost while eyes and ears send the danger message to the brain. Even more time is needed for the brain to send its orders to the muscles. The total delay usually amounts to from one-half to one second.

The explanation is that although people fall rather slowly in comparison with other moving objects, the speed is nevertheless sufficient to carry them out of reach of saving supports before they can think of what is happening and decide to make the required motions. In the time of an eye-wink, a person will fall only two inches. But in half a second, which would be a rapid reaction time for a person who had not expected to slip, the fall will be four feet. In one second the distance fallen will be sixteen feet; the speed increasing by about



Quick-thinking drivers, whose reaction time is one-half second, should allow these minimum distances of safety at the speeds indicated.

(Continued on page 107)

"Folks, That's Ramblin'!"

Will Rogers Gives the Low-Down on Covering The Country by Way of the Airplane

By CARL HELM

Published by Arrangement with the McNaught Syndicate

THE little Kansas town was in a turmoil of excitement. The reception committee, all decked out to meet the Speaker of the Evening, was anxious and nervous.

Here the town was, flags a-flying, and the Distinguished Guest had failed to show up! The 6:27 train from the metropolis had chugged in and chugged out, but the Speaker wasn't on it. And it was the last train.

Downhearted, the townspeople were leaving the station when an airplane roared overhead and landed in a pasture across the railroad tracks. Out of the cockpit stepped a smiling gentleman, a portable typewriter in one hand and a grip in the other.

"Well, folks," he drawled, as the reception committee charged down on him, "here we are. Gosh, I'm hungry! Come four hundred miles since lunch. That's ramblin', folks, that's ramblin'!"

Here he was at last—the long-lost Speaker of the Evening—the famous Will Rogers.

"Thank goodness you're safe, Mr. Rogers!" the welcomers gasped. "Risking your life in an airplane like that!"

Will just smiled.

A famous flyer and a famous passenger. Colonel Lindbergh (right) and Will Rogers in a Ford plane ready to fly from San Diego to Los Angeles.

"NEVER ride in a train when you can find a good airplane with a good pilot," he replied. "Saves you time and money in the long run, folks. And look at the fun you have!"

If that happened once it happened a dozen times this season and last as the world-famous cowboy comedian hopped by airplane from town to town on his nation-wide lecture tour. He was Speaker of the Evening in more than three hundred towns and cities, in every state in the union, and made four stops in Canada.

Will's good friend, Colonel Lindbergh, may be the Air Ambassador to our foreign neighbors, but Will is the Air Ambassador to the far-flung towns and counties of our own nation, one of the best and hardest working boosters for commercial aviation that ever sat in a cockpit.

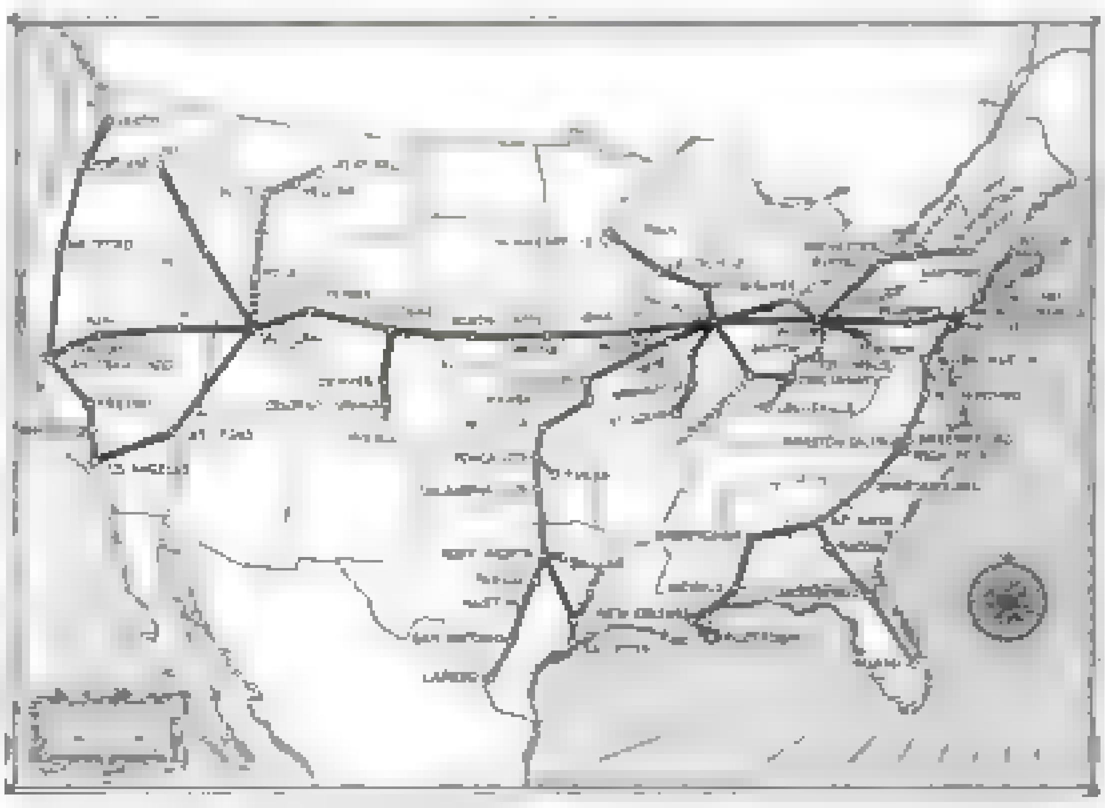
We have our heroes of the air—our Lindberghs and Byrds—to fire the imagination with their feats. We set them on a pedestal, a little above the common run. But Will Rogers, who is "just folks," is bringing aviation down among all of us, into our own little home towns. If he can fly around like a sky-hootin' skylark, so can we, all of us! He has flown between ten and fifteen thousand miles in the last two seasons, riding in air mail and commercial planes with licensed pilots, and next season (from October to June) he plans to fly in a plane of his own. In the *Spirit of Fun*, a Ryan plane, built by the makers of Lindbergh's famous *Spirit of St. Louis*, Rogers plans to cover at least two thirds of the United States.

IT COSTS almost twice as much to travel by airplane as by rail. Will admits it. But the humorist has been able to cover more ground in his one-night-stand lecture tours—and more ground means more money! And he will tell you his disposition has been improved by sleeping in a real bed every night instead of in a stuffy, cindery sleeping car!

But those are not the only reasons that prompted Will Rogers to choose to fly. He's "air conscious"—to a greater degree perhaps than any other of America's prominent citizens. He flits from place to place over the map because he wants to make every man, woman, and child of us "air conscious" too. He wants the whole country to get up and root for aviation.

But there's one thing Mr. Rogers would like to say on the subject right now, and he isn't smiling or joking when he says it.

"I don't advise flying with anybody that happens to have something that is shaped like an airplane. But I do advise, with the utmost confidence, anyone flying with our real recognized air passenger lines."



The latest air mail map of the United States. Virtually all the planes carry passengers, thousands in a year. In a month 168 passengers flew between Chicago and Dallas.

AS ENTHUSIASTIC as he is, Will never gets into a cockpit until he has himself inspected the plane, and made sure that the pilot is licensed to fly after having met the qualifications set by the Director of Aeronautics of the Department of Commerce.

Then he shakes hands with the man at the stick, climbs in, and says "Let 'er go, Buddy!"

Take a look at the Will Rogers Flying Log of last season. . . . Here's "St. Petersburg to Pensacola, Fla." (The pilot got lost

Will Rogers climbs out of the airplane that bore him from Salt Lake City to Los Angeles on the last leg of a lecture tour. He pounded his typewriter on the wing

in broad daylight and had to land in a cornfield to get his bearings! None of the towns had their names painted on the roofs, and when you're in the air all towns look pretty much alike. That got Will started on a campaign to have towns paint their names on the housetops. He offered to pay for the paint—and a whole lot of them took him up! In self-defense Will had to limit his offer to towns with "four-letter names" and finally to three-letter ones. But it stirred things up, and that's what he wanted!")

Then "Reno, Nev., to Salt Lake City." (That flight was made in a snowstorm.) "Portland, Ore., to Tacoma, Wash." (Will heard that his friend, Richard Barthelmess, and a company of movie actors, were up at Camp Lewis, outside of Tacoma, making a picture, and thought it would be nice to drop in and surprise them.)

"Missoula, Mont., to Butte. Butte to Helena. Helena to Billings. Billings to Sheridan, Wyo." (All in one hectic week.) "Staunton, Va., to New York." (A little side trip off the tour, to appear at a benefit for the Mississippi flood victims.) And "Hershey, Pa., to Washington, D.C." And so on, and on.

This season he started his lecture tour by flying from Chicago to Omaha, and his "air log" shows, as he says, "some ramblin'." "Montgomery, Ala., to Albany, Ga." (This was one of the fastest flights he ever made—100 miles in 70 minutes. Will commented, enthusiastically: "Why, it would have taken me all day to make it on the train. Shows you how great this flying thing is. Say, I could have flown to France ahead of Lindbergh but I just neglected doing it. I had a lot of other things on my mind at the time.")

Will Rogers arrives by airplane at Pinehurst, N. C. Behind is the pilot, Lloyd O. Yost, of Hazleton, Pa

"SALISBURY, N. C., to Pinehurst, N. C." "Louisville, Ky., to Columbus, O." "Columbus to Cincinnati." (While flying around over Ohio Will dropped in on the Goodyear folks at Akron and took his first voyage "in one of those blimps." His companion was Judge Ben B. Lindsey, the companionate marriage advocate of Denver, Colo. Will said: "Judge Lindsey and I went up in the air together and discussed companionate marriage. It is over the heads of most people anyway!")

"New York to Philadelphia (2). Des Moines to Cedar Rapids, Ia. Kansas City to Topeka. Salina, Kas., to Claremore, Okla. Claremore to Omaha. Omaha to Los Angeles" for the end of the tour.

The total mileage on his lecture tour alone would put Mr. Rogers way up in front among commercial air travelers, but he has made a Tuesday-to-Friday flight from Los Angeles to New York and return, and flew from London to Moscow, with a stop at Berlin; from London to Paris, Paris to Geneva, and Rome to Paris. All this sky-hopping with his little portable typewriter tucked between his knees in the cockpit, and Will busily pecking away on his memoirs.

HE FLEW from Mexico City to Los Angeles with Colonel Lindbergh last year when the two were spreading good will and joyously held the stick of Lindy's famed plane while it was in flight. That was a red letter day in Will Rogers' History of Aviation.

Will made his first flight three years ago over Washington with an Army pilot who started stunting a bit around the Washington Monument, banking the ship up on one wing as he spiraled around the tall white shaft. It was a thrilling experience for a novice.

Back on the ground, the comedian smiled and said: "I'll say one thing. If that Washington Monument had 'a' had handles on it, you sure would have lost a customer!"

But he didn't mean it. Will's enthusiasm for aviation started that day (or as soon thereafter as he could collect his unstrung nerves). It will continue, he says, "until my beard gets caught in a propeller!"

Will put his preaching (that travel by airplane is not only faster and more enjoyable, but saves time and money) into practice last winter when he hopped from Los Angeles to New York and back on a four-day business trip. It was not a "stunt" flight, but a practical demonstration of the stage to which our commercial aviation had advanced.

A California friend of Will's had to make a fast business trip to New York and left Los Angeles a day ahead of Will by the fastest transcontinental train. Will had been in New York, transacted his business, and was back home in Los Angeles again before his friend had reached Buffalo on the eastbound journey!

The trip cost Will $814, just about twice what he would have paid for railroad fare, Pullman, and meals—but he saved a week's time.

"It was no special trip or rate for me, either," Will said. "It was just the regular trip on the air mail planes that leave every day, and that anyone can walk down and pay their fare and take."

In all his (Continued on page 131)

Timing the Speed of a Bird

By

MYRON M. STEARNS

AIRPLANES and Autos Used to "Clock" the Feathered Tribe, with Amazing Results

A FEW months ago three carrier pigeons wheeled into the air above Hammondsport, N. Y., at 9:01 in the morning, circled overhead, and headed for Auburn, N. Y., fifty miles away. At 9:49 A. M. the first of the birds arrived, making the trip at nearly a mile a minute and losing by only three minutes a race with an airplane.

Stop watches, automobiles, and airplanes have only recently solved one of Nature's greatest mysteries—how fast a bird can fly. Migratory birds are known to cover enormous distances, and one naturalist, H. Gätke, studying them on the island of Helgoland in the North Sea, came to the remarkable conclusion that by rising into the thin air of such immense altitudes as seven miles, even such small birds as thrushes could attain speeds of more than two hundred miles an hour. Though his guess was accepted for years, it was wrong.

Through modern observations made from the swiftest vehicles on earth, we know now that the bulletlike flight of swifts and swallows, and of them alone, can reach speeds of fifty to two hundred miles an hour, with a high mark that would put all but the speediest airplanes to shame. Only four racing automobiles on earth have gone faster.

Wild ducks and geese, records show, can hold their own with the fastest express trains—forty to a hundred miles an hour. Crows and blackbirds at their best can barely outdistance fast race horses at forty-five miles an hour, and laggards among them flap through the air at a thirty-mile pace. A running man can keep up with the slower of the small perching birds, which fly at from ten to thirty miles an hour.

How do we know? By racing birds with mechanical vehicles, and comparing the speed, and also by timing with stop watches their flight over measured distances. Probably bicycle riders were the first to notice that there must be something wrong with Gätke's 200-mile estimate. Cyclists pedaling at a leisurely ten or fifteen miles an hour could easily keep up with birds such as goldfinches and warblers that flew directly ahead of them.

> A FAMOUS runner crouches for the sprint. The starter's gun barks. He's off! Nine seconds and a fraction later he leaps across the finish line.
>
> The crowds are cheering. He has broken the world's record. A distance of a hundred yards he has sped at the panting, exhausting pace of twenty-one miles an hour.
>
> Yet there are tiny birds that he could stuff in his sweater pocket that fly at 200 miles an hour!
>
> Only lately has man been able to time them, and it took his swiftest creation, the airplane, to do it.
>
> "When I was a boy," Mr. Stearns told the editor of this magazine, "my father told me a crow could fly a mile a minute. I never doubted it, but I wondered how he knew. Scientists now tell me it was a guess and it was wrong. Modern timing instruments and faster vehicles have disclosed the facts."

A remarkable photograph of swans taking off, paddling to gain speed. Above: Swans in flight, showing curious ways they hold wings.

With the aid of the automobile's faster pace, an American naturalist, Dr. H. B. Wood, obtained some of the first really accurate information on the flight of small birds. He motored along a prairie road in Kansas, watching the birds roused from the bush by the sound of his car. When, occasionally, one flew off directly in front of him instead of to one side, he was able to chase it and time its flight with his speedometer.

At only ten miles an hour, he found, he could keep up with the undulating flight of a scissor-tailed flycatcher. A Baltimore oriole increased his speed to twelve miles. Stepping on the gas a little harder, Dr. Wood caught up with a prairie horned lark flying at fifteen miles an hour. Seventeen miles, and he was close pressing a nighthawk and an Arkansas flycatcher. Then Dr. Wood sounded his horn, raced his motor, and startled the birds into greater bursts of speed. Driven by fear, he found, most small birds can travel much faster and even sometimes at twice their normal speed. A scared prairie horned lark he passed at twenty-three miles an hour, and others were faster.

TWO other naturalists using his method agreed with Dr. Wood's conclusion that small birds have a top speed limit of about thirty miles an hour. Hugh Gladstone clocked the European blackbird, cuckoo, and missel thrush at twenty-two to twenty-three miles an hour, or about as fast as a crack sprinter runs in a hundred-yard dash. Willow warblers and pied wagtails he found scarcely faster. And Alexander Wetmore, Assistant Secretary of the Smithsonian Institution, timed herons, ravens, shrikes, horned larks, and hawks, and found their normal speeds all under thirty miles an hour and many only twenty.

Now that the slow flight of small birds had been timed, it remained to try to chase and time the speedy ones. There was only one machine that could do it—the airplane. And Col. R. Meinertzhagen, flying for the Royal Air Force in Mesopotamia, set his roaring plane one day in pursuit of a lammergeier, a species of fast-flying vulture. His craft was faster, and when the lammergeier had reached 110 miles an hour it gave up and nose-dived to escape the great mechanical bird at its tail. (Continued on page 110)

Comparative speeds of one of the fastest of birds and man's mechanical speedsters.

The Greatest Overseas Hop

The tri-motored monoplane *Southern Cross* taking off from Oakland, Calif. Loaded with more than three tons of fuel, the ship ran almost a mile before taking the air

Capt. Charles E. Kingsford-Smith, commander, grins good-bye to friends just before the 2400-mile hop from California to Hawaii, the first leg of the 7300-mile journey over the Pacific

How Four Daring Men Made the First Flight from California to Australia, 7300 Miles Over the Storm Swept Pacific Ocean

By ROBERT E. MARTIN

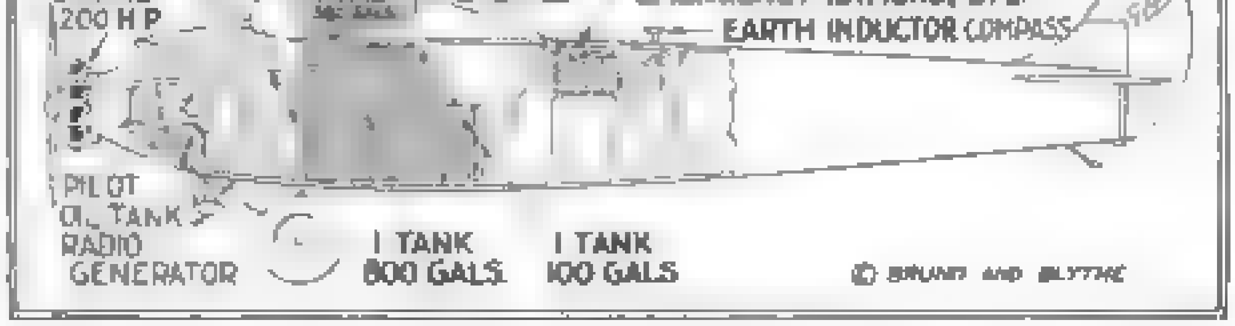
FOR the first time, the Pacific has been spanned by air. Out of the sky, a few days ago, the tri-motored Fokker monoplane *Southern Cross* swooped to a landing at Brisbane, Australia. It had covered more than 7000 miles from Oakland, Calif., in three giant hops, stopping only to refuel at Hawaii and, later, at the Fiji Islands. As it came to earth, a welcoming crowd surged forward about its heroic crew of four—Capt. Charles E. Kingsford-Smith and Capt. Charles T. P. Ulm, Australian pilots, Lieut. Harry W. Lyon, navigator, and James Warner, radio man, both Americans.

By blazing an air trail across the Pacific, one of the last great goals of distance flyers, they had forged the final link for round-the-world air routes. To do it, they made two flights that had never been accomplished before—the 3138-mile hop from Honolulu to Suva, in the Fijis, and another of 1700 miles, from the Fijis to Australia. Even the first 2400-mile leg of their flight, from Oakland to Honolulu, was over a route that had already claimed the lives of ten aviators. Anxiety over a radio flash from their plane, "Guess we are lost," ended two hours later when the hum of their monoplane was heard over the Hawaiian city and they circled to a safe landing.

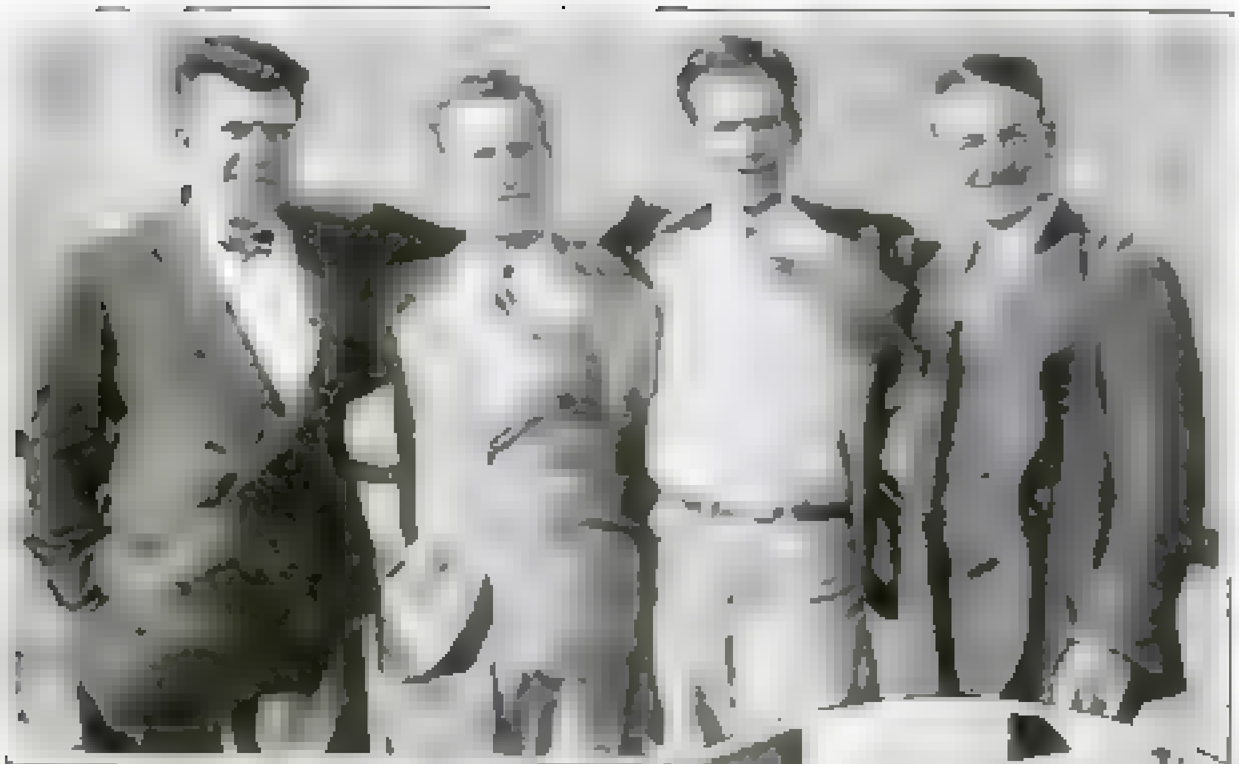
Greatest of all was the hop from Honolulu to Suva. It was the longest water jump in the history of aviation, and close to the longest nonstop flight ever made, Clarence Chamberlin's record 3911-mile hop from New York to Eisleben, Germany. Over Pacific wastes, with only one or two uninviting landing places en route, they had flown more than 3000 miles through lightning and thunderstorms to land at Suva, thirty-four hours after their take-off.

It was a desperate venture—a land machine attempting this record overseas flight. If it fell into the sea it could not rise again. Should the gasoline give out, the crew had but one choice of a "crash landing" place midway—the low, rough, uninhabited coral reefs of Canton or Enderbury Islands in the Phoenix group, 1800 miles out from Honolulu, on which an emergency descent would be practically certain to wreck their plane. When news came that they had passed these without landing, airmen knew that they must make the last thousand miles over water or almost certainly perish in the attempt. And they arrived at Suva with thirty gallons of gasoline—barely enough for an hour's flight—left in their tanks. Expert navigation had guided them to their target: Lieutenant Lyon, Capt. Kingsford-Smith said, had "shot what stars he could find through the black clouds to chart the course to the tiny dot of land."

TREES had been chopped down and a runway improvised in a public park to make a landing field. No plane had ever visited Fiji before. From surrounding islands, thousands of bushy-haired natives had come paddling in, in their crude water craft, to see with their own eyes this new miracle of "white man's magic." They had not long to wait. A thunderous roaring noise smote their eardrums. Over the trees appeared a great blue-and-silver mechanical bird. It gracefully circled the island, dipped, and glided to a perfect landing on the narrow green. Half an



Design of the *Southern Cross*. Two outboard motors, one on each side, have been omitted from the diagram for sake of clarity. Captains Kingsford-Smith and Ulm rode in the pilot's cockpit; Lieutenant Lyon, the navigator, and Warner, the radio man, in the cabin aft of the gas tanks.



The daring crew of the *Southern Cross*. Left to right: Lieut. Harry W. Lyon, navigator; Capt. Charles E. Kingsford-Smith, commander; Capt. Charles T. P. Ulm, co-pilot; and James Warner, radio operator

Lieutenant Lyon with his navigating instruments. It was largely through his skill that the *Southern Cross* on the second hop found its way, through storms and over vast ocean wastes, to island specks in the South Seas.

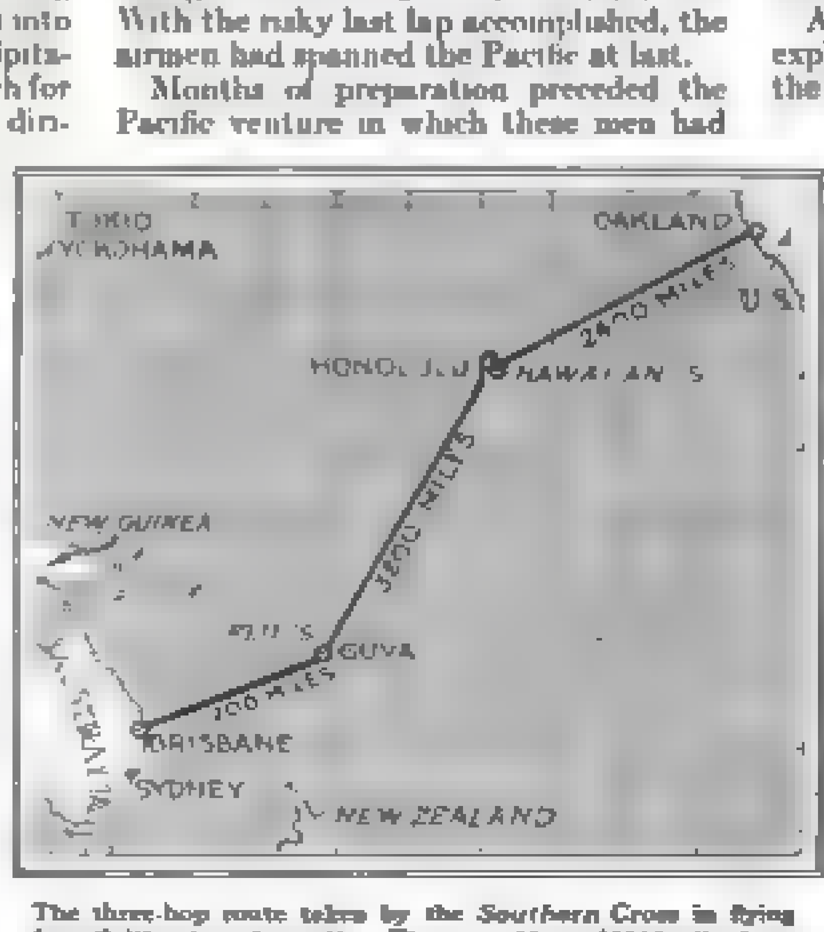
hour later the Suva radio operator was flashing far and wide the message: *Southern Cross* arrived Suva [illegible] P.M.

The achievement came at a time when vivid news of the aviation world was in the making. Up in Trepassey Bay, Newfoundland, Miss Amelia Earhart, Boston, Mass., social worker, was grooming her own tri-motored Fokker pontoon equipped for sea landing, for a trans-Atlantic flight to Europe. Piloted by Wilmer Stultz, ex-pilot of the ill fated Grayson attempt, and with her crew completed by Louis Gordon, mechanic, she aspired to be the first woman to cross the Atlantic by air. Meanwhile rescue parties were rushing with airplanes and ice-breaking ships into the frigid polar regions between Spitsbergen and Franz Josef Land to search for Commander Umberto Nobile, whose dirigible and crew had been forced down somewhere at the top of the world on its return trip from the Pole.

BUT even these events, for a moment, took second place in importance. For, far off in the Pacific four men, watching with strained eyes their dwindling supply of gasoline, had raced against death for the last 500 miles of their epochal flight and had won.

Only a 1700-mile flight to Brisbane, Australia, shorter than either of their two previous hops, remained — but that course lay through a region swept at the time of year they had chosen by the most violent tropical storms. Moreover, the aviators were forced to take off from Suva with just enough gasoline for the trip. A heavier load would have required a standard landing field, something which Suva did not possess, the improvised field on which they had landed with almost all their gasoline gone was barely large enough for their descent from Hawaii. With the risky last lap accomplished, the airmen had spanned the Pacific at last.

Months of preparation preceded the Pacific venture in which these men had cast their lot together—a delay that evoked considerable criticism, but which actually insured the success of their record-breaking flight. Among other tests, three endurance flights were made in the trans-Pacific plane by Capt. Kingsford-Smith and a co-pilot, Lieut. James B. Pond. One of them came near shattering [illegible]'s record. No item of safety was overlooked, and when the plane finally took off it carried a collapsible boat, emergency rations, and a radio set to broadcast the craft's progress, use radio beacons along the way to guide it, and call for aid in case of disaster.



The three-hop route taken by the *Southern Cross* in flying from California to Australia. The second hop of 3200 miles from Hawaii to Suva was the longest nonstop ocean flight ever made.

THE ship itself was a curious composite, the result of rebuilding two planes originally constructed for the Arctic explorer, Capt. George H. Wilkins. In 1926, Wilkins, who recently succeeded in flying across the polar sea from Alaska to Spitsbergen, had bought, for a proposed Arctic flight, a single-motored Fokker craft and another with three motors. After a series of misfortunes forced temporary abandonment of the plan, the aircraft which had made a number of long Alaskan flights, were shipped back to Seattle. Out of the fuselage of the single-motored plane, and the wings and landing gear of the multi-motored machine, the *Southern Cross* was built. It still carries the same gasoline tanks with which Wilkins had hoped to reach the North Pole.

Three Wright Whirlwind engines powered the silver and blue ship, with its wing spread of seventy-two feet, when it started its westward flight. A narrow "catwalk" led to the port and starboard engines beneath the wings to give access for repairs. More than three tons of gasoline poured into the tanks at Oakland prepared the ship for the take-off.

Already distinguished for their previous exploits were the men who climbed into the plane with no more ceremony than if they were going on a picnic, Capt. Kingsford-Smith and Capt. Ulm in the pilot's cockpit, and Lieut. Lyon, navigator, with Warner, radio man, in the cabin aft of the gas tanks.

CAPT. KINGSFORD-SMITH, in command of the *Southern Cross*, was a member of the Royal Flying Corps during the World War. His co-pilot—Capt. Ulm, also a commercial aviator of Sydney, Australia—was wounded three times during his service with Anzac troops in the war.

The radio operator, James W. Warner, of San Francisco, retired a month ago from the U. S. N. with the rating of chief radio man. And one of the most experienced navigators in the Navy, Lieut. Harry W. Lyon, Jr., was "avigator" of the *Southern Cross*'s flight. Son of a rear admiral, he commanded navy and marine vessels for thirteen years.

Uncle Sam's Mechanical Army

Terrific Smashing Power of New "Gasoline Brigade" Tested in Mimic Warfare

By ELLSWORTH BENNETT

An 8 inch railway artillery gun hurling a 200 pound shell at the foe

NEARLY three thousand Army men, recruited from infantry, cavalry, tank corps, and air squadrons, have just formed at Camp Meade, Md., such an Army unit as has never before been seen. Neither infantry nor cavalry, it is an experimental fighting regiment that rides in tanks and motor trucks to overwhelm an enemy by sheer speed. It has been nicknamed the Gasoline Brigade. And this month it is demonstrating whether or not it is destined to banish trench warfare and to revolutionize military tactics with its power of surprise attack.

Purely an offensive force of shock troops, with no staying power, is the Gasoline Brigade, the War Department says. It would use the striking power of fast tanks to smash enemy ranks and capture positions that the follow-up troops would hold. It has its own artillery, manned by specially trained gunners and whirled into action by speedy caterpillar tractors. In short, it is an army of machines. War in the trenches, it may well be, may disappear when these flying squadrons of death take the field.

In all sorts of weather the Gasoline Brigade at Camp Meade is competing against the old style horse-drawn fighting units to show its superior mobility. A light tank six times as fast as infantry speeds into imaginary battle with two gunners, pride of the Army, it scoots over the ground at eighteen miles an hour, and its cruising radius of eighty miles keeps it in action for a whole day without returning to its base. With its one-and-one-half-inch gun and a machine gun besides, its function is that of the light destroyer on the sea. Behind the armored wasp comes a land battle cruiser, a four-man tank belching smoky death from its six-pounder. Twelve miles an hour is its (Continued on page 130)

A powerful small tank with 18 miles an hour speed climbing hill in maneuvers.

Cadets of the United States Military Academy at West Point on one of the gun-carrying tanks, learning what they may have to do if the Gasoline Brigade dominates future war.

The Weakling

A Real Romance in Which a Winged Ship and Its Pilot Gave Helpless Men Mastery Over the Storm

TWENTY-ONE years ago, when Lord Northcliffe offered $50,000 for a flight from London to Manchester, England, a rival paper offered $50,000,000 to anyone who could fly five miles out of London and live. Today men have flown the ocean and through raging storms. The dramatic scenes of this story bear witness to our growing dependence on the airplane as a valiant and trustworthy servant.

FOUR boatmen wearily followed their chief into the Coast Guard headquarters and soberly threw themselves on the nearest bench. Water dripped from their sou'westers and glittered on their yellow oilskins. The cutting salt air of the November night had numbed their hands. Eagerly they reached toward the hot radiators.

For twenty hours an ugly souther had swirled across the bay, turning Rocky Point into a maelstrom of flying spume and mountain-high beach combers. It had been a rough day for the life-savers. Early that forenoon a schooner loaded with lumber had been driven on the treacherous rocks of Devil's Reef. With the fury of desperation, the life guards had toiled ceaselessly with boat and lines until the last man of the doomed ship's crew had been dragged to safety. But no cheers of a multitude met the rescuers. Instead, their bloodshot eyes now turned toward an empty locker.

Once again the cruel sea had taken its toll. Jeb Hanson would never again hang his coat on that iron hook. But such was their everyday prospect . . .

The door opened softly, and a tall, stoop-shouldered young man entered. He stepped to the chief's desk.

"Hello, Chief," he said. "Understand you're one man shy now—any chance to take me on?" He puffed at a cigarette.

Chief Macfarland hurled his sou'wester to a chair and swelled his thick chest as he glared at the applicant. "How many more times have I got to tell you this is a man's job! What chance

"There he comes! He's made it!" cried the chief. Like a huge gull the big snow-covered biplane swooped downward through the storm.

By
ALZO WYNN

Illustrated by Anton Otto Fischer

would you have had today, in that hellish sea? No place for a weaklin' there, I'll tell the world!"

The burly chief stamped across the room. The tall young man smoked thoughtfully. He seemed neither abashed nor discouraged.

"Listen," he urged hoarsely. "I'm not afraid of a little puddle of salt water, Chief. If you'll take me on, I'll work for nothing. I'd bale water from the boat—or anything. Only give me a chance to go out with the boys—"

CHIEF Macfarland scowled. "Man, can't you understand? I can't take on a—a cripple like you. Why, balin' water's only a woman's job. I've gotta have a man with a strong back, a man with grit. Oh, thunder, Jack—I hate t' turn you down but you're simply no good here—"

The Weakling glanced pitifully toward the silent men about the room, then, clenching the friendly smoke between his chapped lips, walked absently out to the street. As the door closed behind him, the petty officer spoke up.

"Too bad, Chief, he got all stove in; he's sure got the grit. They say Jack Rivers was one of the best air aces in the service. I heard tell that he got a score of German planes before he had that last crash. Perhaps you didn't know it, chief, but that poor feller carries a silver plate in the top of his skull, an' a length of tubing in his chest—"

Macfarland muttered an oath. "No, I didn't know that, Handy. Thunderation, an' I called him a cripple! Jove, he's got the nerve to keep teasin' for a job in this hellish business. But what can I do, Handy? He can't pull an oar—his back's bent like an old man's . . ."

It was the ninth of December, and Friday. A month had passed since Jack Rivers had asked for a job in the Coast Guard Service. But although the Weakling had not asked again, he had hovered around the men. Like a shadow, he'd suddenly appear on the bleak beach and help with the wet lines, or perhaps help push the lifeboat up the rollers. Of late he'd been seen hanging around the hangar where a big biplane was stored for the winter. Sometimes when the hangar doors were opened wide, the boatmen had seen Jack Rivers fussing about the airplane engine, renewing his old life.

Tonight, Chief Macfarland had been too worried to even think of the Weakling. For twenty-four hours a raging gale had been hurling white-topped combers sullenly against the rocks of Devil's Reef. Night and day the men of Rocky Point had been forced to keep ceaseless vigil, each moment dreading to hear some signal of distress from a helpless vessel. A slashing gale had grown into a blizzard.

WHITE foam turned to sleet, and blinding snow whipped the reddened faces of the life guards. The warning drone of the foghorn from Great Light made the inky darkness more dismal, while the powerful searchlight cut only a dim finger of white into the swirling tempest.

No one had seen a storm like this before.

Like a caged lion, Chief Macfarland nervously paced the observation room of the Coast Guard house. He had reason to be worried, for that noon he had picked up a radio message from the steamer *Sunbeam*, telling him that his wife and daughter were aboard that steamer. The *Sunbeam* ought to pass Rocky Point about eight o'clock that night!

Eight o'clock came; half-past; nine. Perhaps the *Sunbeam* had gone out to sea for safety. Still, that would be unlike Captain Bruce. With Scotch grit, he'd be more likely to keep persistently on his course . . . As these thoughts surged through Macfarland's mind, the door burst open; a boatman, coated with ice, appeared out of the swirling night.

"Steamer on the rocks, Chief!" he gasped.

Macfarland groaned. The *Sunbeam!* "You sure, Mike? Isn't she just tootin' account o' the fog?" His voice was hoarse and pleading.

The boatman knew that two women dearer to Macfarland than life itself were in peril; he hated to be the bearer of the dread news.

"I couldn't have been wrong, Chief," he said. "She's sendin' up rockets, an' burnin' red flares—"

The chief shrugged into his pea-jacket and oilskins. Grimly he ordered his men to get the Lyle gun and the new life car ready. He was glad now that he'd persisted in adding this water-tight car to the equipment; he shuddered to think of his wife or daughter making the trip across the waves tonight in the old style breeches buoy.

A few minutes later, the stern-faced band of life-savers were fighting their way toward a point opposite Devil's Reef. They were forced to drag the two-hundred-pound gun high up on the shore, for each succeeding wave seemed to pound a little higher than the one before. The ice-cold wind swept against them. Blinding spray filled their eyes.

The chief swore loudly as he spied the lifeboat. Early in the evening it had been pulled for safety high up on the beach; now it was half full of water. Soon it would be pounded to splinters, or sucked back into the seething breakers.

As Macfarland placed his hand on the boat's gunwale, the petty officer stared at him in amazement. He knew that no boat could live a minute in that hell of waves and wind.

"Goin' to try launchin' her?" he shouted.

Chief Macfarland threw his weight against the ice-coated stern with an oath. "No! I'm goin' to push her farther up; may need her, later on—" he gasped as he turned his worried eyes toward the doomed steamer.

FOR the first time in their lives they hauled a lifeboat away from the ocean while a ship was sending up distress signals. Then once more they staggered on with the heavy cannon, life car, and ropes. Impossible to see more than a few yards in the tempest, but the pleading whistle of the foundering steamer was all the compass they needed.

Every man there had a mental picture of Devil's Reef. Like the sharp-edged fin of a shark, the ledge of black rock loomed out of the water, ready to cut into the vitals of any ship unfortunate enough to touch it, while at either side the water sloped to unknown depths.

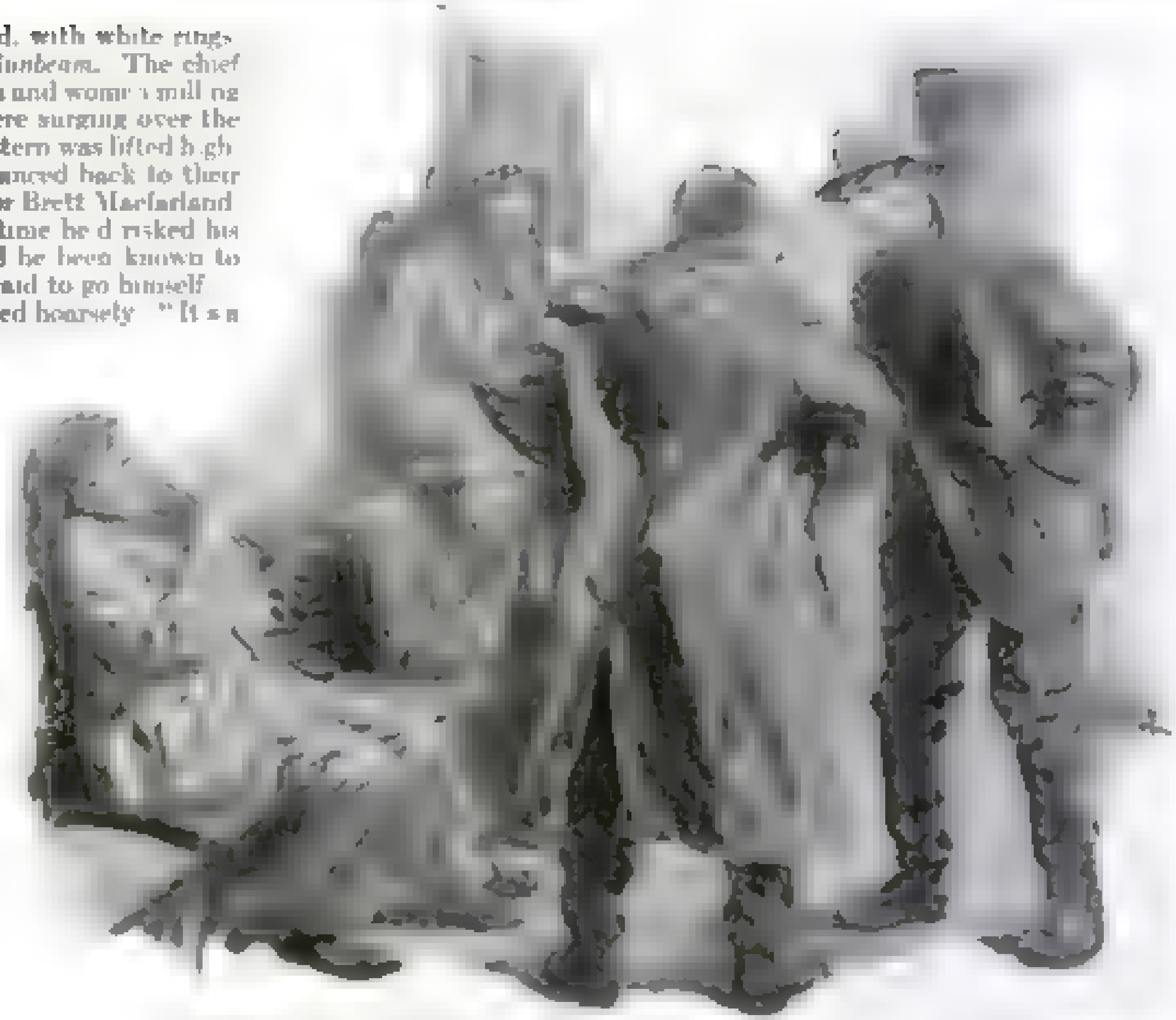
Suddenly a red flare lighted the upper deck of the big steam-

ship. Two big stacks painted red, with white rings left no doubt that she was the *Sunbeam*. The chief groaned as he beheld huddled men and women milling about the deck. Giant waves were surging over the submerged bows, while the great stern was lifted high.

Instinctively the life guards glanced back to their leader. Every heart there ached for Brett Macfarland. They loved their chief—many a time he'd risked his life to save theirs, and never had he been known to ask a man to go where he was afraid to go himself.

"Man the gun, boys!" he ordered hoarsely. "It's a long shot out there, but we gotta make it, somehow!"

The men worked swiftly. The life line on its wooden frame was set in position beside the Lyle gun. Quickly the pegs were pulled, leaving the coils free and clear to unwind without friction as the missile was hurled toward the helpless ship.



The chief glared at the Weakling. "How many more times have I got to tell you this is a man's job! What chance would you have had out there today in that hellish sea?"

CHIEF MACFARLAND'S hands trembled as he aimed the gun. A boom, and an eighteen-pound projectile hurtled into the air. Anxiously the men watched the unwinding coils. Suddenly the line was motionless. The missile had fallen short!

"Pull her back, boys!" the chief's heart was cold within him. The ship might go down before he could reach her! As the line was hauled back and coiled on the pegs, Macfarland ordered red flares set off along the shore. It would encourage the distressed passengers; they'd know that someone was trying to help them.

Twice more he tried to force the missile over the sinking vessel. Useless! Even with the wind to help, seven hundred yards was the limit for the Lyle gun. The *Sunbeam* was lying at least a thousand yards distant, with the wind at an angle to force the missile to one side each time it was fired.

The petty officer sprang forward and grasped the chief's arm. "The wind's goin' down," he encouraged. "See—she's lettin' up. I believe you can do it, next shot!"

Macfarland knew it was useless to try again, but what else was there to do? As he stood there, helplessly, watching his men coil the wet line, he suddenly felt a touch on his shoulder, and looked up to meet the dark eyes of Jack Rivers.

"Can't make it with the gun, can you?" shouted the Weakling above the noise of the pounding waves.

MACFARLAND turned angrily. "I'm goin' to, an' fer God's sake keep out of the way! You can do that much, can't you?"

The Weakling pulled the collar of his shabby raincoat about his throat. His hands were bare and blue with cold.

Soon the eighteen-pound missile was ready again to be hurled. Macfarland started to adjust the gun, then with a gesture of utter helplessness, motioned to the petty officer. "You try her this time, will you, Handy? I'm all shaky."

The gun boomed. Once again the wet line hurtled out. It was going farther this time; the wind offered less drag against it. The red lights flared up brighter from the ship, and for an instant the decks were in sharp relief against the blackness of the night. But no sign of the life line. It had swerved to the north. Again it had failed!

The Weakling stepped close to Macfarland. "Any passengers on her, Chief?" he asked nonchalantly.

Macfarland turned upon him. "Passengers! Man, my wife an' daughter are on that steamer! If this gun don't reach 'em —I'll swim out with the line—" His great fists clenched.

But the Weakling did not flinch. The man who once had been a flying ace seemed to be calculating. He leaned closer to the chief's ear.

"I don't want to butt in," he shouted, "but you can see that your gun isn't in it with this storm. I can show you a sure way to get the life line over—"

Something about the Weakling's confident voice urged Macfarland to listen. He was frantic, at the end of his rope.

"What—what is it?" he asked incredulously.

The Weakling, a different man now, suddenly straightened to his full six feet. He pointed one grimy hand toward the upper beach.

"Up there in the field is a perfectly good airplane. I helped fill her gas tanks yesterday. Give me a couple of men and a crowbar, and I'll dig her out of the hangar."

FOR a second the chief was interested. Then he shook his head. "It's no use, Jack. It would take more than a whole man for a job like that. Why, you couldn't get her off the ground in this hellish wind—"

The Weakling's voice was pleading.

"I'll manage somehow. Just get me the crowbar, will you?"

Again the chief shook his head. He was about to turn away when the petty officer spoke up.

"Mac," he said, "I'll help Jack dig out the airplane."

A comber swirled at their feet; for an instant the men were half buried in the white froth and ice-cold spume. Then

"All right, Handy, go ahead. It's no use, though. This feller will never make it—"

The petty officer was already off on a run toward the tool house. While he was gone, the Weakling gave his instructions.

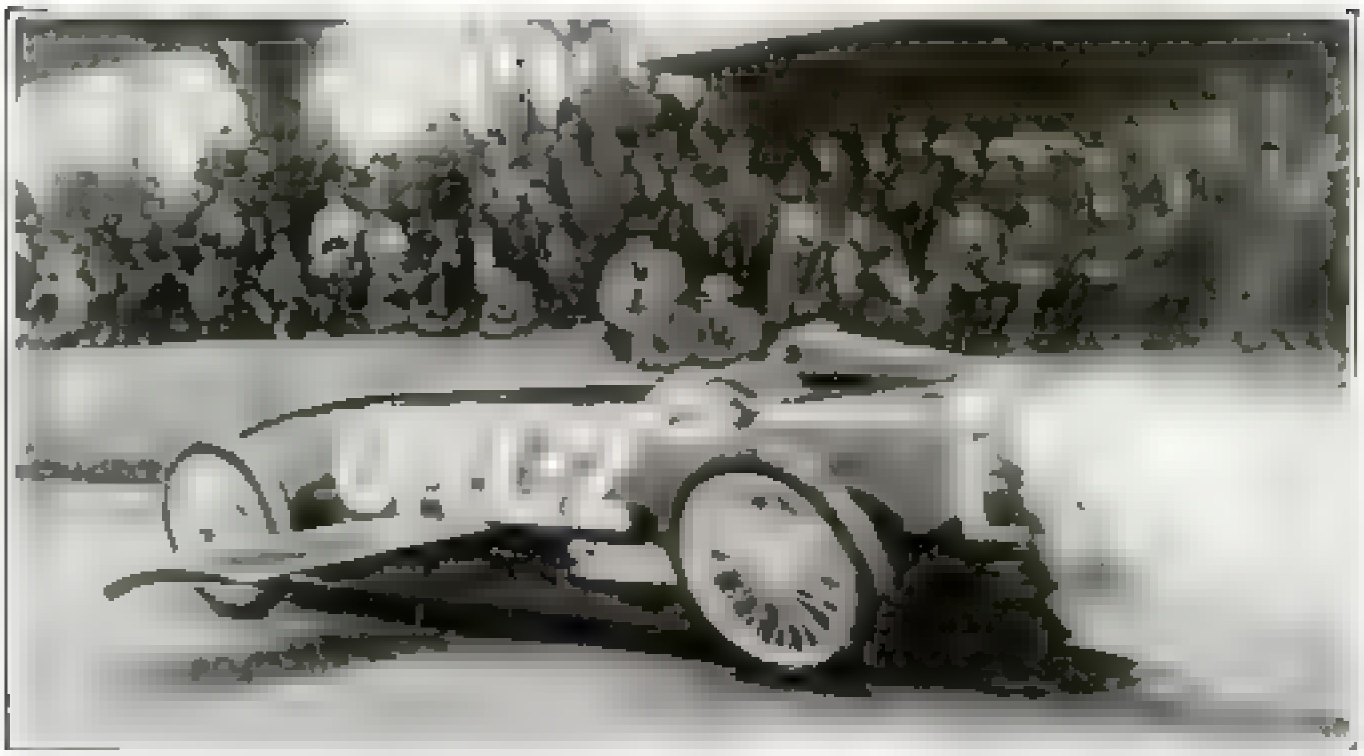
"You'll have to make a fifty-foot loop, with a running noose in the end of this life line," he explained. "Have two men spread apart and hold the loop up over their heads, with the bottom part of it resting on the sand. After I bust in that hangar door I'm going to tie the iron bar to one end of a rope and let her dangle over the fuselage. When I get going, I'll fly low. I reckon the iron bar will tangle in the loop, if I have good luck, and I'll cut her loose over that steamer. Might loan me your jackknife, Chief, I haven't any."

CHIEF MACFARLAND placed a big hand on the Weakling's shoulder.

"You got the grit, boy," he said, "If you only had a whole back, you might have a chance—but anyhow, we'll do our part."

A few minutes later, accompanied by the petty officer and a boatman, the Weakling disappeared in the direction of the airplane. Jack Rivers' last words rang in the chief's ears and left a tight feeling to his throat.

"If I don't happen to come back, (Continued on page 124)



The twenty-four-rocket car attaining a speed of 120 miles an hour in eight seconds at the start of spectacular trials in Berlin, Fritz von Opel at the wheel. Note the wings that hold the car to the ground

Rockets Drive Amazing Auto

Spectacular Tests of Fire-Spouting Car May Lead to Bulletlike Aircraft Built to Hop Atlantic in Minutes

By THOMAS ELWAY

A FEW minutes past four o'clock one afternoon recently on a private race track in the little town of Rüsselsheim in southern Germany, a dozen or so invited witnesses saw a human being fired for the first time ahead of a rocket.

The vehicle was a road rocket. Man-carrying skyrockets are being planned as the next step in the experiment. Even before this article can be printed the first rocket-driven aircraft may have been fired skyward, perhaps to return safely and open a new and amazing door for progress in aviation, perhaps to crash disastrously and cost the life of its gallant volunteer pilot, Anton Raab.

About the ability of rocket motors to drive automobiles at speeds hitherto undreamt, there is now no question. At Rüsselsheim, a racing car driven by twelve rocket tubes attained a speed of more than sixty miles an hour in eight seconds. Later, near Berlin, a second vehicle reached twice this speed in the same time. A rocket airplane and still larger rocket automobiles are under construction. Whatever the final result may be, the long-discussed idea of rocket motors for human transportation at last is having practical trials.

Credit for the rocket idea goes to an American, Professor R. H. Goddard, head of the Department of Physics of Clark University, at Worcester, Mass. He was the first who saw clearly, nearly twenty years ago, that no other vehicle known to science could continue to drive itself in a vacuum, like that of the empty space between the stars. If man is ever to visit the moon or Mars or any other planet, it must be, so far as science can now imagine, by the use of rockets. Ordinary aircraft cannot leave the earth's atmosphere. To fire human beings in a projectile shot from a giant cannon, as was imagined years ago by Jules Verne, would result, experts are agreed, in crushing the passengers to instant death by the shock of the discharge.

Max Valier, young Viennese engineer who originated the road rocket. He is now applying the rocket principle to an airplane which will be designed to shoot at least ten miles into the air.

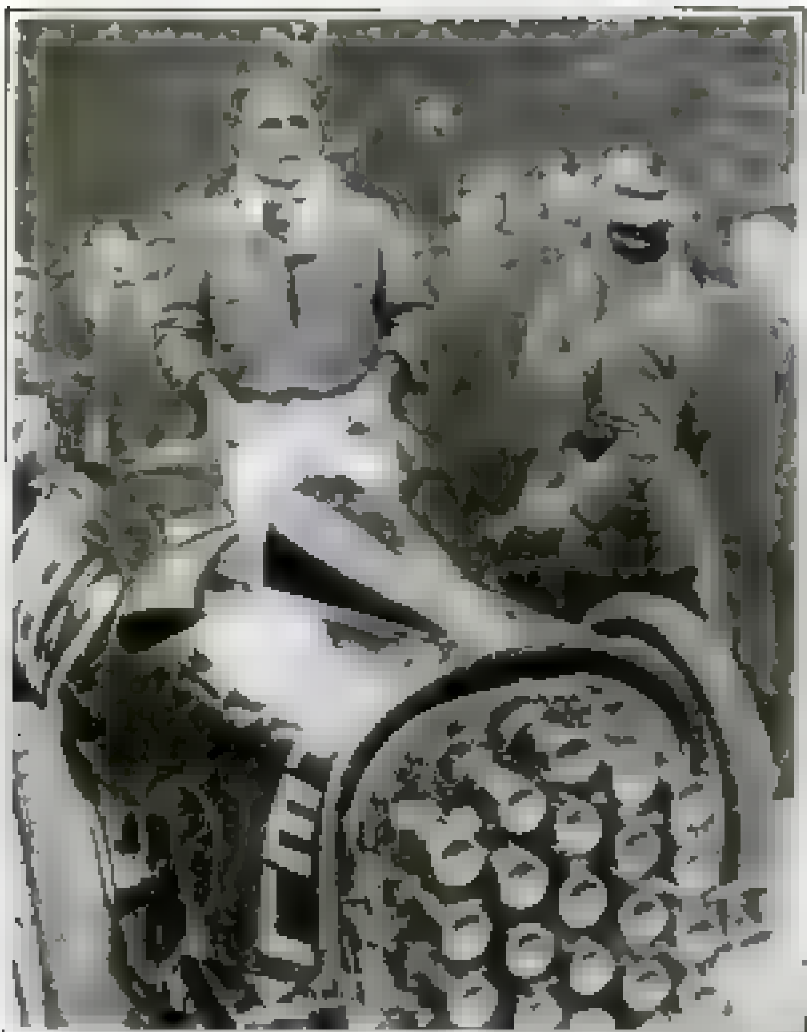
Three years ago Professor Goddard urged construction of a small rocket to rise fifty or a hundred miles and bring back samples of the highly electrified gases supposed to constitute the only air at these enormous altitudes. Professor Goddard even fired small model rockets in a vacuum in experiments which he described in POPULAR SCIENCE MONTHLY.

In Berlin, Dr. Hermann Oberth confirmed the American's calculations. Franz von Hoeff, an engineer of Vienna, worked out this year designs for four types of space rocket, the largest of them a gigantic cigar-shaped object weighing no less than 600 tons and capable, it was computed, of a round trip to Mars. The distinguished French aircraft expert, Professor Robert Esnault-Pelterie, also confirmed Professor Goddard's calculations and prepared detailed rocket designs.

THE Smithsonian Institution has approved the Goddard idea of an untenanted rocket to sample the highest levels of the air.

A few months ago Robert Condit announced himself about to start on a rocket voyage to the planet Venus. He and his rocket disappeared from public view, although presumably not to Venus. Later he said he still planned to go. He may try.

But the most active disciple of Professor Goddard proved, however, to be the young Viennese engineer, Max Valier, who interested Fritz von Opel, venturesome young racing automobile driver and an executive of the great Opel



Rear view of the twenty-four rocket car showing steel tubes which expel gases to drive the car at great speed. Standing in the cockpit is Fritz von Opel, owner of the auto

Automobile Works. To these men, cooperating with Friedrich Sander, rocket expert and K. C. Volkhart, automotive engineer and racing driver, are due the spectacular trials of the rocket-propelled cars at Russelsheim and at Berlin.

In the first trial Volkhart climbed calmly into the untested vehicle. Nervously his three partners shook him by the hand, not knowing whether they would see him a few moments later alive or dead. Spectators retired to a safe distance from the fiery discharges of twelve steel-tube rockets fixed to the rear of the car.

Valier waved his hand as a starting signal. Volkhart pressed the lever igniting the first pair of rockets.

INTO the space behind the car exploded a vast cloud of white-hot gas and smoke. The car shot forward with incredible speed, vanishing instantly in the dense smoke cloud. Before this smoke had cleared Volkhart was climbing out half a mile away almost stunned by the jamming of the back of the seat against his body as the car shot ahead, but otherwise none the worse.

The twelve rockets that drive the car are of two types. Four are starting rockets, built and charged with explosive to produce instantly a powerful forward thrust. Two of these explode simultaneously. Within about one second they have consumed their charges of gunpowder and spent their force. Immediately the other two starting rockets are fired automatically. The operation of the four is complete within about three seconds.

The other eight rockets are of a slow-burning type whose construction is a closely-guarded secret of Sander. Each burns for about forty seconds. Their duty is to overcome the friction of the air and the roadway, thus maintaining the speed which the quick-burning rockets imparted.

These eight rockets can be arranged to explode automatically two by two at proper intervals, or they can be fired at will by the driver from a small control board on the dash. The rate of firing governs the speed. At present, even in the twenty-four-rocket car in which Opel gave the second demonstration at Berlin, there is no way of recharging the rocket tubes and when they are exhausted the car must stop. Recharging in transit is one of the problems still unsolved.

Roaring down the stretch in a cloud of smoke and white-hot gas. Slow-burning rockets, exploded at proper intervals, maintain the two-mile-a-minute speed which quick-burning rockets imparted at the start

Aside from the rocket motors, the chief novelty of the Opel-Sander car is a pair of short, thick airplane wings projecting from the sides of the chassis just behind the front wheels. These are not to lift the car but to prevent lift. Inclined exactly the reverse of airplane wings, they utilize the air pressure created by the rapid flight to press the car powerfully against the road and make it possible to steer. Steering is done precisely as in any motor car. Brakes of the usual type stop the car if necessary.

NOT even the four hopeful fathers of this Opel-Sander car consider such rocket motors likely to be practicable for automobiles. The public would never permit such fire-spouting, speed-defying demons on the highways. Furthermore, the efficiency of the rocket motor, measured in mechanical power yielded by a given amount of energy in the fuel, is less than that of the ordinary gasoline engine. The road rocket is not an end in itself but a step toward something more important, toward aircraft or space craft independent of the earth's atmosphere.

Ordinary airplanes are held up by the "lift" of the air under their wings. They are dragged ahead by the resistance of the air against their spinning propellers. Ships are driven similarly by the push of the revolving screws against the water. Locomotives and automobiles move by virtue of the friction of their wheels against rails or roadway. Even trotting horses or walking men must use this same frictional push of the feet against the ground.

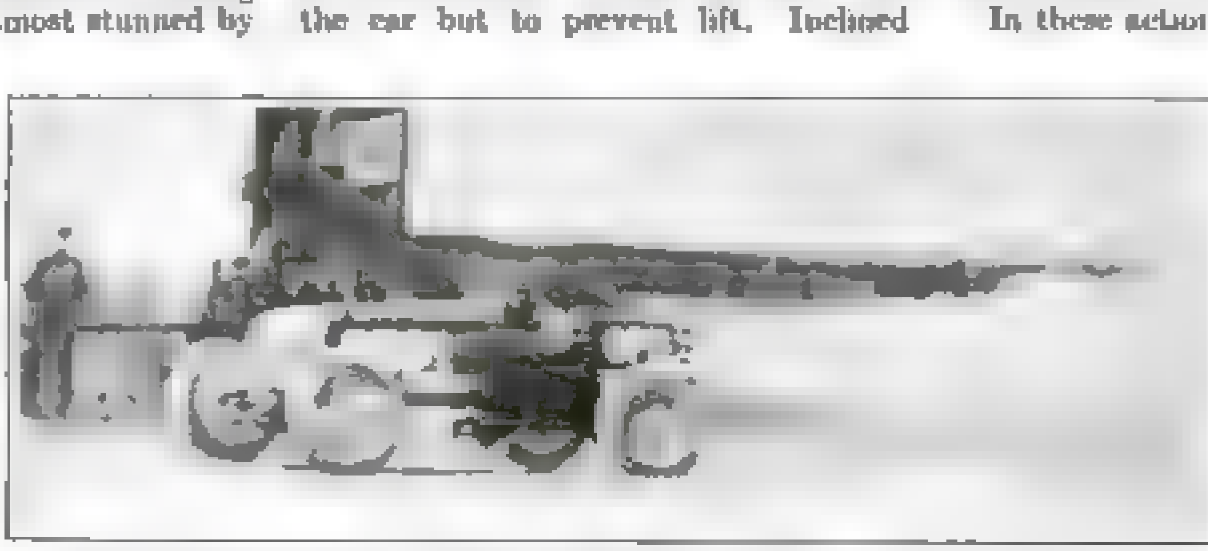
ROCKETS do not need this something to push against. If they do not actually lift themselves by their own bootstraps, they do something almost the same: they kick themselves ahead against their discarded boots, the "boots" being the gases which they emit.

Sir Isaac Newton pointed out two centuries ago that action and reaction are equal and opposite. When a gun is fired the action is expressed in the forward flight of the bullet, the reaction by the backward kick of the gun. This kick occurs even with a blank cartridge, the gases discharged from the barrel representing the action. When a boy standing on ice skates throws a baseball the boy is driven backward by the effort just as the ball is driven forward, although less rapidly because the boy is heavier. When the gases of the Opel automobile blow violently out of the twelve steel tubes the car is driven forward.

In these actions and reactions neither the air nor the ground are necessary. Professor Goddard proved that a blank cartridge fired from a revolver in a vacuum still kicks the revolver backward. The Opel road rocket would have attained its speed even more spectacularly in a vacuum than in air.

To test these conclusions by a rocket-

(Continued on page 109)



The fire-spouting speed demon literally kicks itself ahead by backward-shooting gases. This principle, applied to aircraft, may permit flights through space beyond the earth's atmosphere.

Doctors Die Fighting Fever

Famous Bacteriologists Sacrifice Their Lives in Africa to Win the Thirty-Year-Old Battle Against Yellow Plague

By L. G. POPE

AN ARTICLE in the May issue of POPULAR SCIENCE MONTHLY told of the thrilling adventures of warriors of science who have risked and sacrificed their lives for the world in the conquest of disease.

To the long list of these heroes and martyrs now are added the names of the famous Japanese-American bacteriologist, Dr. Hideyo Noguchi, and of his colleague in research, Dr. William Alexander Young. Their recent deaths from yellow fever on the plague-ridden Gold Coast of British West Africa signalized a triumph over one of the last strongholds of the disease.

Not since Dr. Jesse Lazear and other brave men of the Walter Reed Commission walked thirty years ago into the jaws of death to prove that mosquitoes were the carriers of "yellow jack" germs, have there been recorded more thrilling deeds of courage and self-sacrifice.

Last November Dr. Noguchi, deliberately risking his life, volunteered to journey to West Africa for the Rockefeller Institute for Medical Research to study the bacteria responsible for a yellow fever epidemic there. It had just killed a young British pathologist, Dr. Adrian Stokes, studying the epidemic in the same territory.

DR. NOGUCHI'S mission was to isolate the African germ, and to discover whether it was the same as the organism responsible for the American form of the scourge, for which the Walter Reed Commission had developed an antitoxin. The first goal he accomplished by sleepless labor in the shadow of peril; the second he realized only in the agony of death.

Dr. Noguchi was inoculated with the American serum and on a lonely African coast, far from home and friends, began experimenting on monkeys with fever-carrying mosquitoes. Dr. Young, as Director of the Gold Coast Medical Research Institute, labored with him.

In less than two months, Dr. Noguchi felt a fever come upon him. Knowing instantly that he had fallen victim to an infected mosquito, he kept silence. Later, he wrote to friends of his in America:

"In spite of every imaginable precaution, I was caught and had a narrow escape. No one ever suspected I had it, but I knew from the beginning what was the matter with me."

Three days after last Christmas, Dr. Noguchi was compelled to go to a hospital at Accra for treatment. There, on his sick bed, he performed an amazing experiment, drawing some of the infected blood from his own weakened body, and having it injected into the body of a monkey. The animal quickly died.

Dr. Hideyo Noguchi, who deliberately risked yellow fever and who, dying of it, made experiments with his own blood that led to mastery of the plague

By the time Noguchi left the hospital, the answer to his problem was in sight. The quick death of the monkey indicated that the American serum offered some measure of protection in Africa, else why had not he, too, quickly died? On the other hand, the very fact that he, though inoculated, had contracted the disease, was evidence that the American antitoxin had only checked, not routed, the African germs.

The next thing was to run down and isolate the enemy. After weeks of incessant labor, aided by two American and fourteen native assistants, he was able to write home:

"I have the organism that causes yellow fever in Africa."

The tropical germ which had defied science, he said, was evidently a more deadly member of the same family of bacteria which causes the disease in South America.

All the while, the enemy he hunted was continuing an undermining attack on his own body. Last March he wrote again:

"Suppose I have discovered the cause of this dread disease? The irony of it all is that I probably have it."

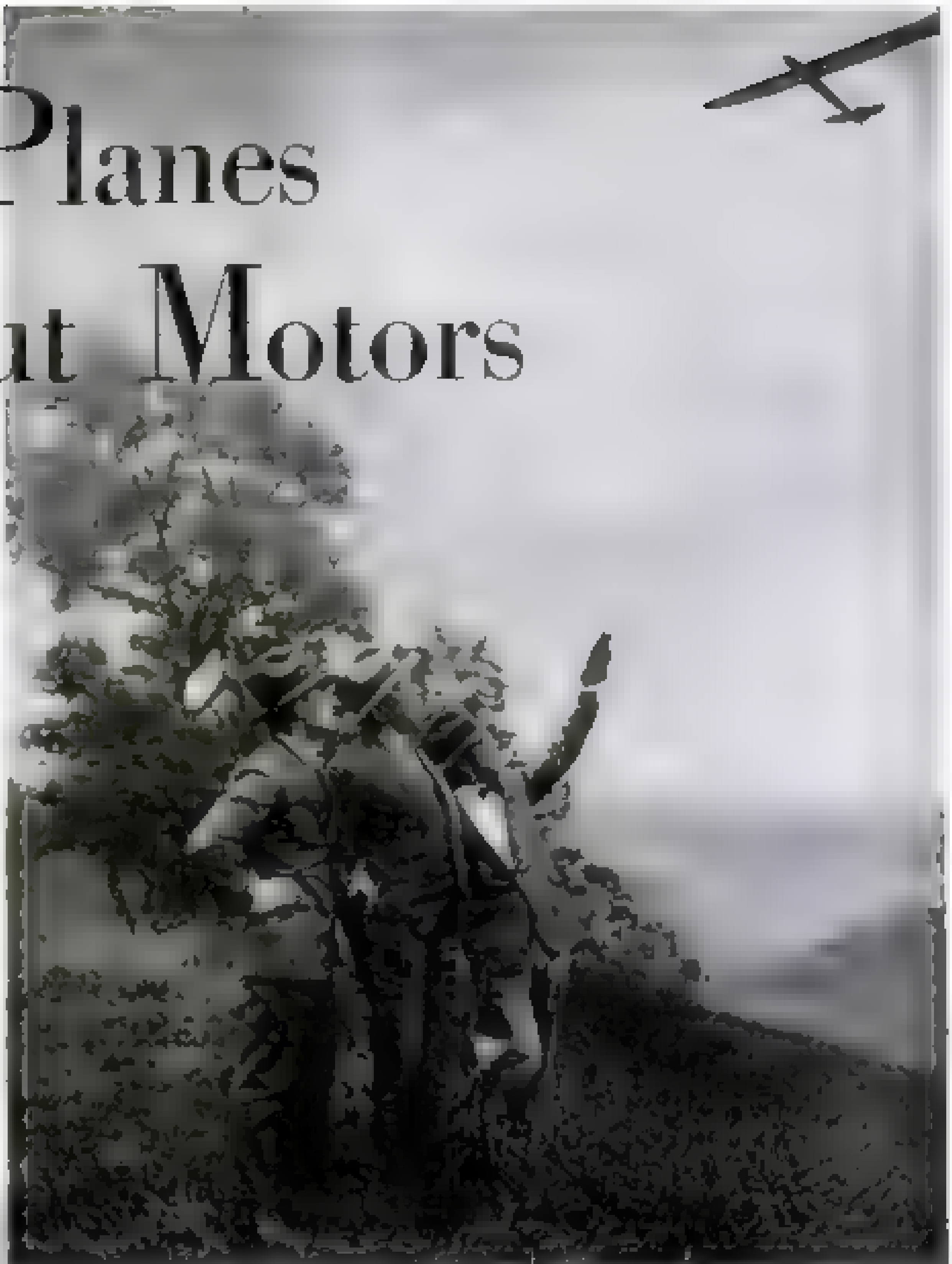
He was right. On May 21, just when his researches had been completed, and two days after the date he had chosen to sail for home, he died. In death he was able to answer what in life he had labored to prove—that the American and African forms of the disease are not the same, and must be attacked with different weapons. Less than two weeks later, Dr. Young also succumbed to the disease, which he evidently contracted during his researches with Noguchi.

A SLIGHT, nervous little man, Doctor Noguchi often was called "little giant" and "human dynamo." When on the trail of some new discovery he would work night and day for weeks until his problem was mastered. His devotion to relief of human suffering was evidenced by the fact that in his African quest he had everything to lose. Born in Japan of humble parents in 1876, and educated in colleges in Japan and America, he had risen to the heights in his profession. For his battling of diseases he had received high honors from governments, institutions, kings, and emperors.

His greatest achievements were in the cultivation and study of disease organisms responsible for infantile paralysis, rabies, syphilis, paresis, smallpox, yellow fever, and trachoma.

One of his last and most important works was the discovery, by two years' research, of the germ of trachoma, an eye disease which physicians say is probably the greatest single cause of blindness. The success of his experiments, in which he inoculated monkeys with the disease, gave hope at last that the scourge soon could be prevented. For this discovery he recently received the silver medal of the American Medical Association.

Flying Planes Without Motors



The three German experts who have come to interest America in motorless gliding watching the flight of one of the new Darmstadt type gliders they brought with them. Left to right: Peter Hesselbach, Capt. Paul Roehre, and Dr. Paul Laubenthal. In the photograph at left is seen a German glider soaring over the sea from the top of a sand dune

German Experts Show America How to Make Gliders Soar as Birds for Hundreds of Miles

By ALDEN P. ARMAGNAC

THREE German aviators arrived in this country the other day and announced they had come to teach America to fly without gasoline. These three, Capt. Paul Roehre, Dr. Paul Laubenthal, and Peter Hesselbach, were experts of ten years' standing at flying gliders—airplanes without motors. They came at the invitation of the American Motorless Aviation Club, formed to foster gliding in the United States.

But before their arrival, students of the Massachusetts Institute of Technology had been busily turning out what is said to be the first fleet of gliders on this side of the Atlantic. They will fly them at Cape Cod.

Meanwhile an organization of glider enthusiasts, the American Glider Association, has been formed in Detroit. Their instructor is Harry Karcher, Detroit aeronautical engineer, who has devised a system of teaching that begins with theory of motorless flight and ends with students flying their own self made machines. He plans eventually to extend the association's activities to coöperate with other schools all over the United States.

Flying a plane without a motor sounds like nonsense—but it isn't. One day in May, last year, Ferdinand Schultz, German pilot, launched his motorless soaring plane *Westpreuben* from the top of one of the great sand dunes that border the Baltic Sea in northeastern Germany, and soared, dipped, and soared again for fourteen hours before he descended with a new world's record for sustained flight in a wind-driven craft. From morning until after sunset he had steered his feather-weight machine so skillfully that rising air currents had buoyed him up and kept him aloft. Compare that with two other gliding records—the Wrights', of ten minutes, that stood for ten years as a world's record

How a glider can soar for hundreds of miles. On the windward side of each hill is an ascending current of air. The experienced pilot "hops" from one hill to another successively spiraling aloft on these updrafts to regain altitude for the next swooping glide across country.

until the German, Harth, in 1921 raised it to twenty-one minutes.

Other pilots, today, are making flights as far as 300 miles, often to predetermined goals. Schultz himself, last October, won the altitude record for gliders by rising 2,205 feet—nearly half a mile—above his starting point, with no motor to drive him.

Today's records top a phenomenal development of gliding in Germany that grew out of the war and the Versailles peace treaty. Before the war, gliding in Germany, as in America, had been practically at a standstill. Laid away in museums and forgotten were the first crude, unsafe gliders of the German pioneer Lilienthal, like those of his pupils, Chanute, Pilcher, and later the Wright brothers, that had paved the way for motored aviation. Then came the war and a treaty of peace that dealt a virtual deathblow to Germany's airplane industry—and with new enthusiasm, Germany turned to motorless flight.

Modern gliders, beautiful craft of thirty-five to sixty-foot wing spread, were built. Some had dual controls, for teacher and pupil. Others carried one, two, or even three persons. From high mountains, husky ground crews of ten or a dozen men catapulted these new craft into the air with towropes. They soared to records that astounded a world which remembered the frail batlike wings on which Lilienthal ran downhill and launched himself in the air—the last time, to his death. Now, with safe machines, Germany had modernized gliding.

Today fifteen thousand Germans—boys, girls, serious-minded business men, of all ages from fourteen to sixty years—glide for the sport of it, for gliding is about as near as a human being can come to flying like a bird. Soaring clubs in Germany are as numerous as golf clubs here; almost every town of any size boasts one. Gliding has its practical side, too, where new air pilots are trained in gliders by the Lufthansa, Germany's national flying organization, on the theory that a man who has learned the air's whims in a motorless plane is best qualified to pilot a motored craft.

Three German experts have brought with them to America six of the finest "sailplanes" or gliders that Germany has built. At important cities they will exhibit and fly the craft. And this fall, at Kitty Hawk, N. C., America's first national glider competition is planned.

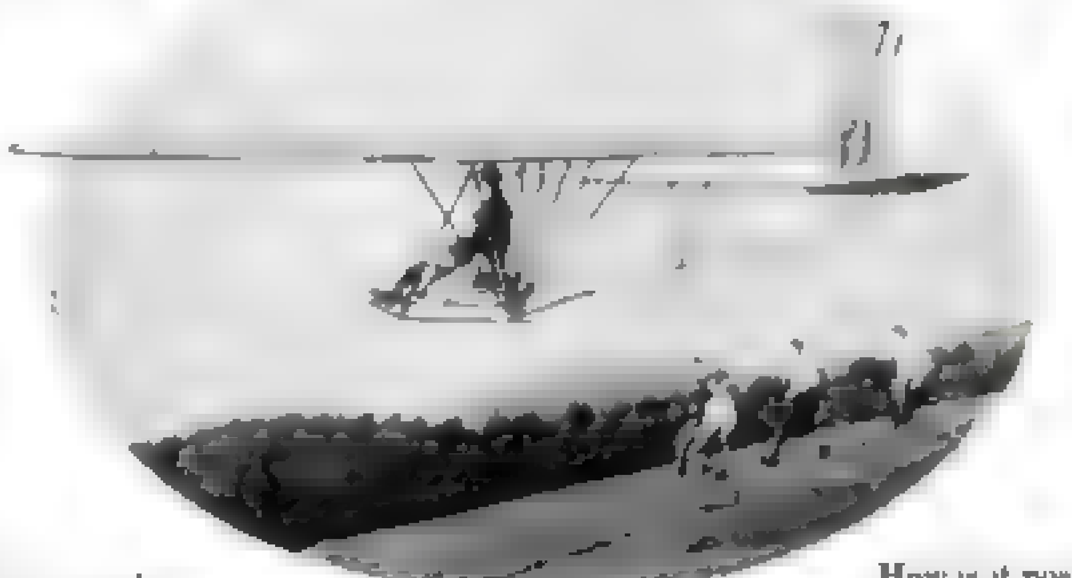
By that time, amateur glider flyers may dot the hillsides. Intercity gliding, too, is possible. Recently, for instance, the German experts surveyed air conditions along the Palisades, the great cliffs that border the Hudson River from New York City northward. They declared that with a favoring east wind to give buoyant updraft along the cliffs, an experienced glider pilot could easily soar from Albany to New York—an airline distance of more than a hundred miles.

How is it possible? How can a pilot fly a motorless plane where he will, for hundreds of miles, without coming down? An airplane pilot, his motor stalled, must speedily look for a landing place. But a well-built glider, thanks to its extremely light weight, can soar three times as far as an airplane before it comes to earth. While his light craft is slowly descending, the pilot has plenty of time to find an air current that will buoy him up again.

Such rising breezes are not found by accident; the experienced glider pilot knows exactly where to look for them. When the wind blows against any obstacle on the ground—a row of houses, the edge of a forest, a sand dune, or a ridge of mountains—it swerves, and creates an upward draft of air. Every hill has, on one side, such an ascending air current. A pilot has but to steer his glider into the draft to feel himself being lifted.

That is the secret of motorless flying—to attain elevation by spiraling in an updraft of air, and then to swoop down across country to the next hill or dune and repeat the process. Thus pilot Schultz was able to soar for fourteen hours over sand dunes in the upwind of strong breezes from the sea. And in the Rhoen mountain district of Germany, where other long-distance records (Continued on page 154)

A stiff climb. Future airplane pilots of the Lufthansa training school in Germany struggle to the top of a steep hill to launch their practice glider.



A featherweight glider leaving a hillside on its first test flight. The framework of this craft is of thin plywood, and its wings are of light-woven linen.

A modern streamlined glider, taking off. Observe the hills in the distance—ideal country for successful long-distance gliding.

How a glider is launched. A ground crew, by a double rubber rope, tows the craft downhill into an ascending wind. At a signal, they drop the rope, and the glider soars away on the wind's updraft.

Fighting a 50,000-Acre Fire

Ohioans Battle Blaze That Started Before They Were Born and That Has Burned Continuously for 44 Years

By FRANK E. NICHOLSON

AT NIGHT the sky glows dull crimson—from the fires of smoldering craters. The heavens burn with an awful light. Now and again a pillar of flame leaps up in a silent explosion.

A pall of smoke, a blanket of steam, darken the sun by day. Belching holes pit the countryside, mile after mile. Hills are barren, desolate. Gaunt bones of dead trees fringe the valleys. The very ground is burning!

This is no fanciful land of volcanoes. It is a once smiling district in Perry County in southeastern Ohio, where the "biggest fire on earth" has burned unchecked for forty-four years.

Fifty thousand acres—sixty-five square miles of fair hills and valleys—are doomed by a creeping destruction that nothing has been able to stop!

This is in a section of the Hocking Valley, a rich bituminous coal field. More than 700,000,000 tons of coal have been destroyed by this underground fire. It has laid waste to oil fields and ruined vast deposits of clay which once supplied busy potteries.

Two generations, watching the fire grimly approach their homesteads, have fled at the last moment. Babies have been born under the smoking skies, and grown to maturity to fight the fire in vain. It would seem that human ingenuity had been defeated by Nature in malignant mood.

But Nature is not all to blame. Man started the fire himself, whether by accident or design matters little. It was during a strike of coal miners in 1884 that a string of coal cars, filled, burst into flames just inside the old Plummer Mine. The disputing factions said, "Let 'er burn!"

NEXT morning, when responsible officials on both sides awoke to the common menace, the fire was beyond all control. Residents believed it would run its course and die out, but, after months, smoke issuing from wide cracks in the earth told another story. The fire was furiously following the vein of rich coal a few feet below the surface into other mines.

The State Department of Mines tried shutting off air to smother the flames. But the earth beneath the fire collapsed, deep fissures were opened and craters formed. Through these the fire received more air, and with the draft burned more fiercely, rounding bases of hills and crossing valleys. Mine after mine was abandoned.

Streams were dammed, and canals made to carry water into the craters. But the water turned to steam, which blew larger craters that served the fire as chimneys. Rain aggravated the situation.

Chemicals were tried in vain. Cutting the coal veins with deep, broad ditches proved tremendously costly and only partly effective.

The smoking craters almost surrounded the old town of Straitsville. The plucky refugees set up another town—New Straitsville—out of the path of the advancing fire.

Dozens of oil wells were enriching their owners. The fire swept up beneath them, melting the pipes, destroying the derricks. Potential millionaires became poor overnight.

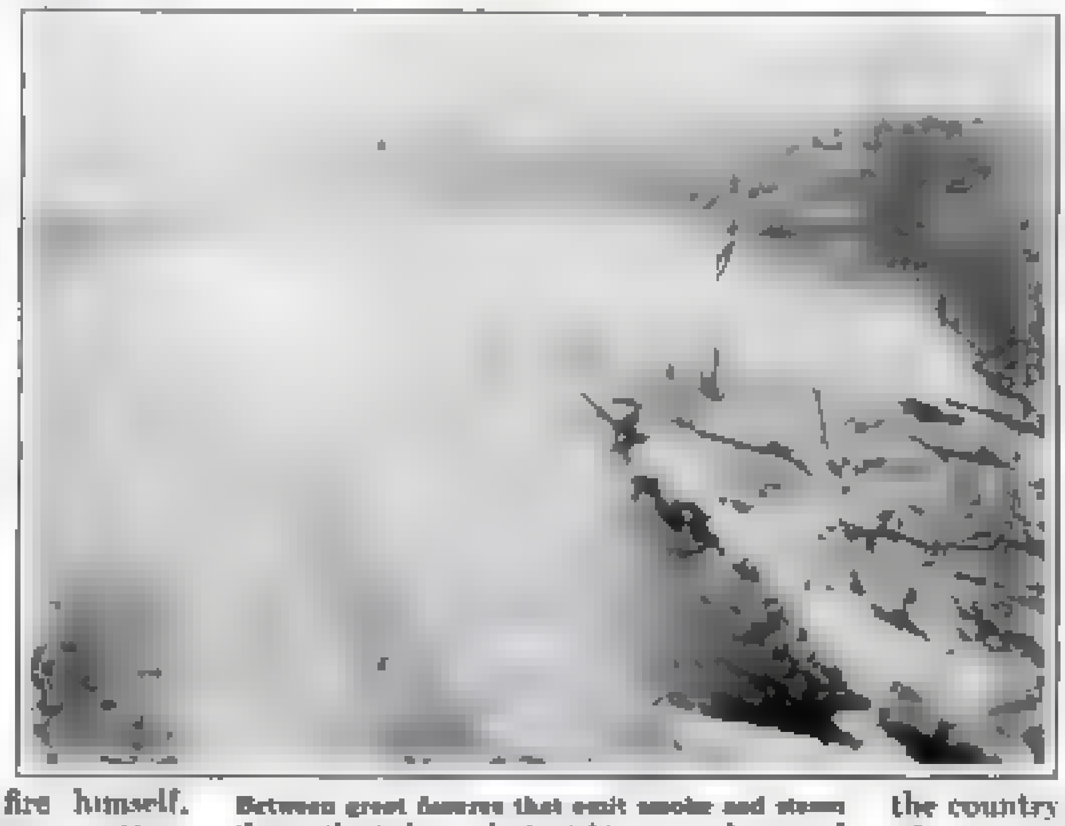
THE outstanding attempt of private individuals to check the fire came in 1900 when the Jones brothers—John, David, and Evan—bought 1,000 acres and spent several hundred thousand dollars in every conceivable method before they gave up. Even parallel brick walls of tremendous thickness with soot filled in between were of no avail. Fire and steam burst through.

Today, scattered all over the country, are abandoned houses, trees whose roots have been burned, yawning chasms of charred, steaming earth. Here is the site of an old schoolhouse that tumbled into such a chasm. There is an ever boiling stream, even in the coldest weather. Here, where the soil is merely warmed, spring flowers bloom in winter.

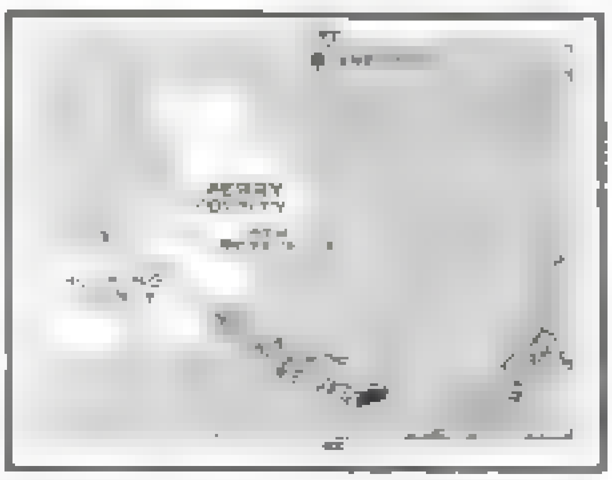
Along the brick-paved road that skirts the burning lands, cave-ins are frequent. Signboards warn the traveler. Just off the highway is a cottage, the fire burning on two sides. Smoke and steam come from a crater near the back door. Into the fuming crater the cottagers throw garbage! From their cistern they draw hot water.

Only some small owners cling to their holdings, slowly retreating before the fire's advance. Many of the inhabitants remain. One lives, if one must, in the midst of the "biggest fire on earth."

A crater that has spouted steam for twenty years as the coal beneath the surface has burned. Babies born after this fire started have grown into men to fight it for a few years hopefully and then finally to quit, declaring the struggle impossible to win.



Between great fissures that emit smoke and steam the earth sizzles and at night grows cherry red with the burning coal beneath. Beyond this part of the doomed countryside lies the town of Straitsville, which has been abandoned to the earth fire.



The map shows the location of Perry County, Ohio, where 700,000,000 tons of coal has been burned in the ground and 50,000 acres laid waste.

One of the amazing results of X-ray research—the new cathode ray tube, mysteriously powerful, developed by Dr. W. D. Coolidge in the General Electric laboratories.

Amazing New Jobs for X-Rays

How They Pierce the Heart of Metals, Expose Flaws and Fakes, Grow Super-Hens, and Save Men from Hidden Peril

By BOYD FISHER

Professor John T. Norton, Massachusetts Institute of Technology, placing a plate to make an X-ray photograph that will show any flaws in a crank case. His new device is designed to test machinery, thus reducing danger

X-RAY photography has come out of the laboratory and put on overalls. Almost every day it takes on new jobs.

With X-rays, we can peer into the heart of solid metal, wood, coal, or concrete, to judge their worth or detect their flaws. Jewels, paintings, furniture—even the walls of houses—lay bare their innermost secrets. In countless ways the invisible rays are adding to our safety and comfort.

If your friend beats you in golf, maybe the X-ray is helping him! He makes a long, sure drive down the fairway. You follow, and see your ball swerve and finally bounce off into the rough. You may be as skillful as he. The difference is that your friend has mysterious rays working for him, and you have not!

For a perfect drive the center of a golf ball must be absolutely true. So, where the most carefully-made golf balls are manufactured, one man spends all his time looking through the finished balls, to be sure their centers are flawless. That may explain why your friend can outdrive you.

This is only one of the X-ray's many unusual jobs.

In the famous French art gallery, the Louvre, each of the 9,000 paintings is being examined under X-rays to determine its authenticity. Some startling surprises have resulted.

For instance, one of the paintings was supposed to be the work of the seventeenth century Italian master, Carlo Dolci. For two hundred years, people had accepted it as such. Then Professor Fernand Cellerier, of the Arts and Crafts Conservatory, looked at the painting through his newly-invented X-ray machine, which looks like a "magic lantern."

It revealed that what the public saw was not Dolci's work at all. Under the surface paint, on the original canvas, appeared the real masterpiece! Two centuries before, one of Dolci's canvases had mysteriously disappeared. Someone had painted another picture over it, leaving a few faces and the signature showing. Experts were able to peel off the outer layers of pigment and restore the original picture.

Professor Cellerier, applying the X-ray, not only can distinguish an old master from a newer copy, but he can determine within a few months the date at which it was painted! He explains that the rays pass easily through modern paintings, while ancient works are more opaque. This is due partly to a difference in materials, and partly to the fact that all pigments tend to grow more opaque with age.

Another method by which the X-ray determines the original from the imitation is illustrated in the case of Leonardo da Vinci's "Mona Lisa." In 1911, this famous painting was stolen from the Louvre. The event caused a world-wide sensation. For two years its whereabouts were unknown. Then it was recovered and restored

WHAT X-RAYS MEAN TO YOU

WHO X-rays oysters? And why? How can these rays help your game of golf? What do they do toward making bigger and better eggs? Why do antique collectors X-ray the arms of ancient chairs? Here Mr. Fisher answers these questions and many more.

Thirty-three years have passed since Roentgen laid down his glowing bulb on a book to answer a knock at the door and later found to his amazement the first X-ray picture in the world. That discovery first interested scientists, then became important to all men. A great discovery comes of age when it is applied to doing practical work of value to mankind.

Professor Fernand Cellerier in the Louvre with his X-ray machine looks through the surface of a painting. He proved the authenticity of the recovered "Mona Lisa."

to its old place. But immediately the rumor spread that the restored picture was but a clever imitation. Professor Cellerier was able to prove conclusively that the painting is the original.

Under the outer layers of pigment, the X-ray revealed the blurred outlines of other Mona Lisas, showing that in the four years Da Vinci had worked upon the painting, he had made many changes before he was satisfied. A copyist, having the finished work in front of him, would have made no such changes.

X-rays have proved equally valuable in the examination of jewels.

A few weeks ago, an old customer brought an unusually large pearl to a New York jeweler. A fine crack, barely visible, had appeared in it. The jeweler held it to the light and said

"If that crack extends to the center, your pearl is worth only five hundred dollars. If it goes only below the surface, it can be polished away and the pearl will still be worth ten thousand."

TAKING the pearl to his X-ray machine, the jeweler was able to tell in a moment that the damage was superficial

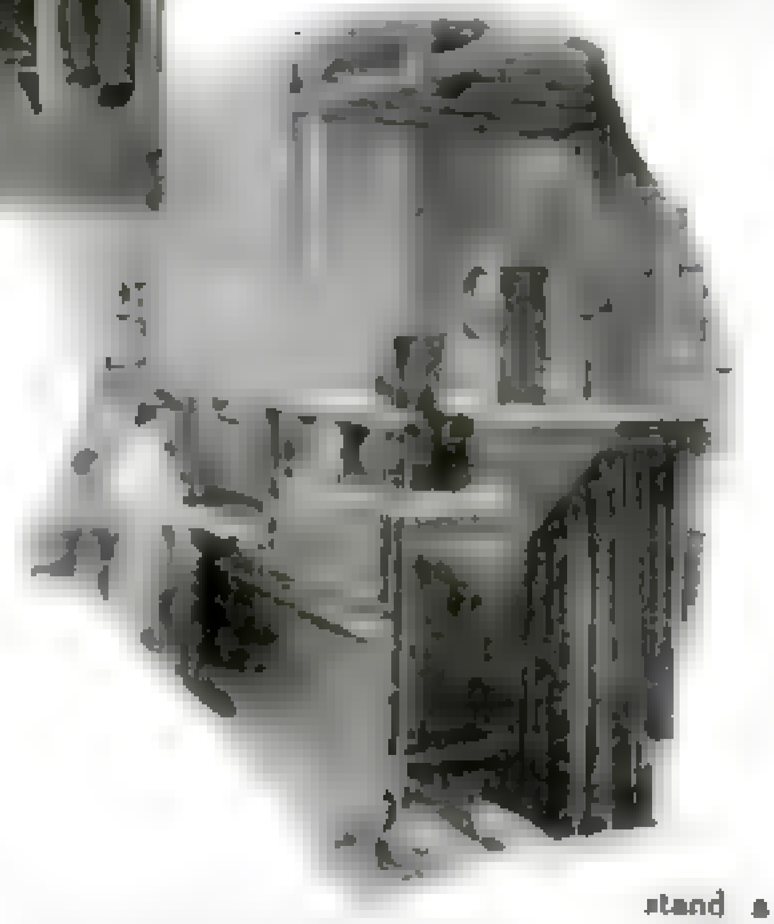
Similarly, the rays reveal whether a pearl is real or imitation. Real pearls glow under X-rays, while imitations, made of high density glass, are opaque. Even the pearl fishermen rely on this new aid to tell the value of their catch. When a boatload of live oysters arrive from the beds, an X-ray expert looks through the shells, one by one, to see if there are pearls inside! If there are, the oyster is opened. If not, it is thrown back into the water.

Collectors of antique furniture have found X-rays a sure safeguard against fakes. For example, if the rays show no wormholes *inside* the wood, they know that holes on the surface were made by gimlets to give the appearance of age.

The latest method of remodeling valuable old Colonial mansions includes the use of X-rays. The architect goes from room to room looking through the walls and finding just where joists and pipes are hidden. Thus, haphazard tearing into walls is avoided.

One of the strangest letters ever written was penned the other day by a University of Illinois professor with the help of X-rays. On a sheet of paper, he wrote a note of no great importance. Then with another pen filled with a colorless ink, he wrote a secret message on top of the first letter. When he laid the pen down, the words he had written last had disappeared.

No eye in the world, unaided, would ever read that secret message. No bath of chemical solution would ever reveal it. But under the X-ray the invisible letters would appear glowing like the hands of a radium watch!



The mica used in telephone receivers and for many other purposes must be perfect. Here is X-ray apparatus that makes sure that it is.

This magic ink is made from a cheap, colorless salt, possessing the strange property of giving off light, like a glowworm, under the influence of the rays. The property is called fluorescence.

In other ways, closer to everyday life, X-rays are on the job for you. When you eat a piece of candy, or brush your teeth, or call "central," or send a cable to France, little do you dream how much you may be indebted to them.

SOME years ago, a costly lawsuit arose over the finding of a piece of glass in some candy. Now, one manufacturer protects himself and his customers by passing each box of chocolates down a moving belt before an inspector who, with an X-ray machine, searches their contents for metal, glass beads, or other foreign objects which might have entered by mistake.

In another factory toothbrushes are inspected in a similar way to see that the bristles are properly set. Slate, intended for telephone switchboards, is X-rayed to assure that it is free from streaks of metal. The rays likewise give the final approval to splices in submarine cables.

If you like eggs for breakfast, or your mouth waters at the sight of a juicy drumstick, you will be further indebted to these rays. They promise larger chickens, bigger and better eggs, and more of them!

Dr. William H. Dieffenbach, of the Flower Hospital, in New York City, has just reported amazing experiments in hatching Plymouth Rock eggs. Some he exposed to X-rays for a few minutes and others for several hours. In those exposed for the shorter period, the usual ratio of males to females among the hatched chicks was completely upset. Almost every chick was an egg-laying female!

When the eggs were exposed for several hours, more surprising things happened. Out of them came chicks, perfectly healthy, but unlike any other chicks on earth! Some had no wings. Other strange changes in form that would require many generations of gradual evolution had taken place in a single generation.

DR. DIEFFENBACH believes that with X-rays he will be able to produce new species of chickens superior to any He found that many of the hens hatched from ray-treated eggs attained a weight far above normal, and that they began to lay much sooner than usual.

X-rays have done much to make factories safer for workmen. Here, for example, is a throttle-valve as big as a three-year-old child. It must stand a pressure of nearly 2,000,000 pounds. The slightest hidden flaw means possible death for men who work near by Since the X-ray will photograph an internal crack no wider than a hair, and will reveal the tiniest cavity, its use has largely eliminated this peril. In many plants, notably the Edison Company's important high power plant at Weymouth, Mass., it is a rule that every casting must be X-rayed before it can be accepted or installed.

Many men have been blinded or killed by abrasive wheels that have "exploded" at high speed while grinding tools. All such wheels now are examined with X-rays and shown to be free from defects before they are used.

At the air mail field at Bellefonte, Pa., a pilot drops down out of an ominous sky, his plane rocking like a catboat in a choppy cross-wind. As he comes to a safe landing he, too, can thank the X-ray. For one of its latest services is examining the wood used in airplane construction, assuring that no internal knots or wormholes will menace the life of a pilot in some hard fight with the elements.

In the Navy, dangers attending practice maneuvers with big guns likewise have been reduced. X-rays have provided the only reliable means of detecting a flawed "nose" in a high explosive projectile, which would endanger the lives of all who might handle it. Big guns also are examined for internal cracks that might cause them to blow up under continued firing. At the Watertown Arsenal, in Massachusetts, X-ray machines have been developed (Continued on page 128)

How the "Modern Iceman" Works

Why the Same Electric Current That Toasts Bread or Heats an Iron Can Keep a Refrigerator Cold

By H. C. DAVIS

MORE than twenty-five hundred readers of POPULAR SCIENCE MONTHLY have asked questions about household refrigeration in the last three months. Most of them have inquired about electric refrigerators.

"Of course I know that in an ordinary icebox the ice absorbs heat from the air," writes a man in Dallas, Tex., "but what I would like to know is how an iceless refrigerator can keep itself cold, and even manufacture ice, when nothing is fed into it but electric current."

The mystery seems even more complicated when you see the same electric current toasting bread and keeping a flatiron warm. As a matter of fact, however, there is nothing very complicated about the basic theory on which electric refrigerators operate. And the way in which these elementary principles have been made to work is amazingly ingenious.

ANYONE who has pumped up a tire by hand has demonstrated the principle governing the operation of an iceless refrigerator. After the tire has been pumped up, the end of the pump near the hose is quite hot. And yet the same air that has passed through it, if let hissing out of the tire valve an hour later, will seem colder than normal.

What happens is this: Every time the plunger of the pump is pushed down the cylinder, it pushes ahead of it the countless billions of vibrating air molecules that form the air in the cylinder. Without them the pump plunger would slam to the bottom without encountering resistance.

As the plunger pushes the air molecules closer and closer together, the compression increases the heat in the air. After being forced into the tire, this air gradually cools down to normal as the heat is passed along to the rubber of the tire, and, in turn, to the outside air.

Just as compressing air increases its heat, so expansion reduces its temperature. And if, while it is compressed, its heat is absorbed by surrounding objects, then when it is finally allowed to expand, it will be colder than it was before compression. There, in a nutshell, is the principle of electric refrigeration.

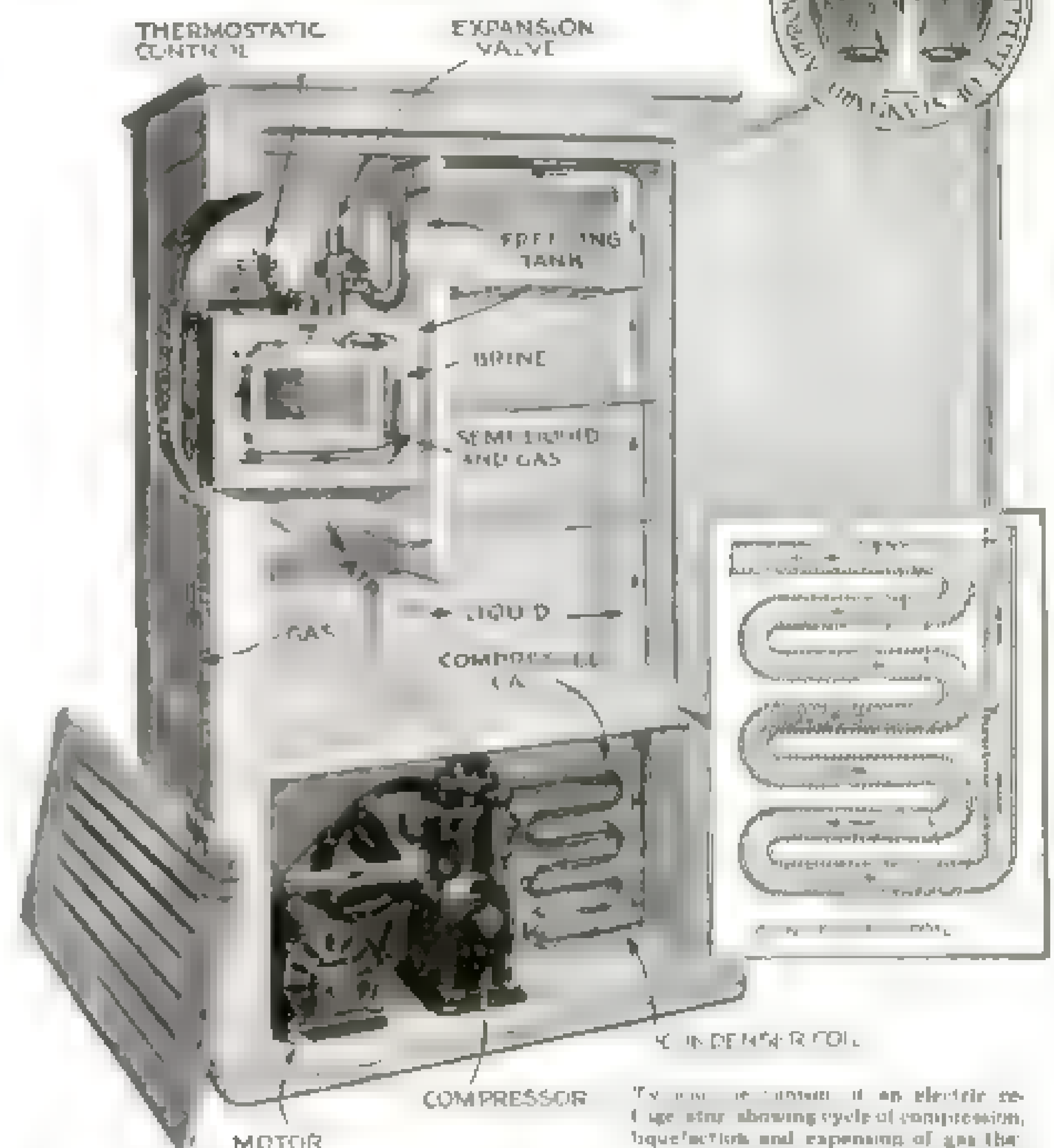
ELECTRIC current is turned into mechanical movement by the electric motor. The mechanical movement is employed to operate a pump, exactly like a tire pump in principle, but marvelously refined and improved in efficiency. Instead of ordinary air, another gas is used, such as sulphur dioxide or methyl chloride. Either of these gases, when compressed, turns into liquid at a much higher temperature than air and consequently is more suitable for refrigeration purposes. Coils of piping connected with a pump are filled with one or the other of these two gases. The current is turned on, and the pump started.

THE gas is compressed just as the tire pump compresses air. The gas becomes hotter just as the air becomes hotter. As the hot compressed gas flows through the piping it gradually cools by passing out its heat, until by the time it reaches the bottom of the pipe it has dropped to the temperature at which it will turn into a liquid.

From the bottom of the long coil of piping the liquefied gas is forced by a pump up through a pipe to an expansion valve at the entrance to another coil of pipes inside a tank full of brine or other nonfreezing liquid. The liquefied gas, as it reaches the expansion valve, is still under pressure from the electric pump, but the pressure inside the coil is very low. This is because the gas is constantly being sucked out of it by the pump. So, when the expansion valve releases a portion of the liquefied gas into the coil in the brine tank, the liquefied gas immediately begins to transform itself back into a gas and literally soaks up all the heat from the brine in the process. The brine tank, in turn, has taken heat from the air in the refrigerator.

This continuous cycle of compression, liquefaction and subsequent expansion goes on as long as the motor runs the pump. Then, when the interior of the refrigerator has been cooled to the desired temperature, a thermostat automatically shuts off the current and does not turn it on again until the air in the refrigerator starts to warm up.

This whole process is depicted on this page. Of course it is obvious that the arrangement of the apparatus shown in the diagrammatic illustration is of no particular importance. The brine tank with the expansion coil inside naturally must be placed in the compartment ordinarily used for ice in the refrigerator, but the motor, pump, and cooling coil may be placed in the cellar or in a special unit placed on top of the icebox.



Typical arrangement of an electric refrigerator showing cycle of compression, liquefaction and expansion of gas that lowers temperature in food chambers.

New Houses for Old

Inexpensive Brick and Stucco Veneers Make Frame Homes Beautiful, Keep Out Heat and Cold, and Reduce Fire Risk

By JOHN R. MCMAHON

DONALD and Ada knew a lot of things about apartments, being a very clever young couple, but when they bought a house they were practically babes in the woods.

They were not cheated, yet the effect of inexperience was almost as bad. When the truth finally dawned upon them they had a heart-to-heart discussion, because they liked the place, the neighbors, and everything. But the house just wasn't what it ought to be in appearance or in fact.

"Let's take our problem to that old retired builder, Mr. Dinsmore," wisely suggested Ada. "If anybody can tell us what to do he can."

"And without prejudice or bias," agreed the young husband.

They found the veteran home builder charging a corncob pipe which, he asserted, was a greater national asset than the gold reserve in the Treasury. After listening to the story of the young couple, he said:

"A new face for an old house—I guess that's the prescription! Not that the dwelling you have is really old, but it looks seedy. For a permanent job, for living comfort, and an appearance to match the other houses in your street, I would advise either brick or stucco. Thus you will combine looks with fire safety and insulation against heat and cold."

"How can a frame house like ours be changed to brick?" asked Ada.

"THAT'S easy," laughed the veteran. "You really do not change anything but simply add an overcoating of brick. Veneer is the term commonly used. Many new houses that seem to be all masonry are brick veneer, and this treatment is becoming popular for old dwellings. An old structure veneered is better insulated than a new one because it includes a layer of siding or shingles that would be omitted in a new building."

"What is the thickness of veneer?" inquired Donald.

"The width of one brick laid flat, which is four inches, or a fraction less if standard common brick is used."

"Have you any figures comparing the insulation value of this veneer with the regular insulation materials?"

"Nothing exact," replied Mr. Dinsmore, "but wood frame is good and when you add to it an air space and four inches of solid masonry the combination is excellent."

"Where is the air space?" questioned Ada.

"That is what I have asked myself on some inferior jobs," responded the veteran with a smile. "There should be an inch between the old wall and the veneer. The confined air insulates and prevents dampness from attacking the woodwork directly. It is well also to have a layer of tar paper on the wood surface. Besides the reasons I have given for that inch of space, it is a working convenience for the mason and takes care of irregularity of brick and differences in plumb between the old wall and the new."

A typical example of the transformation of an old frame house by giving it an overcoat of stucco. Wire mesh was applied all over the outside of the house at the left, then three coats of stucco, the standard number, were put on in an attractive color combination and the result is seen below.

Photographs by courtesy of the Portland Cement Association.

"I should think the veneer standing out that way from the house would be tippy," commented the young woman.

"Allow me to compliment you, my dear, on making a vital point. A four-inch brick wall has enough stability to serve as an inside partition, but on the outside it must be securely anchored to the old wall. A strong gale might damage a poorly fastened veneer. It is common practice to use as wall ties thin strips of galvanized metal bent at right angles, one end being nailed to the old wall and the other imbedded in mortar between the courses of brick. A better and stronger hold is obtained with large nails or spikes driven into each stud at a downward angle just above the brickwork and then bent down with a hammer so as to rest on brick. The nail head is imbedded about an inch in the masonry."

"What size nail and how about rust?" queried Donald.

"Thirtypenny, which is four and one half inches long. A thin strip, although galvanized, will rust out sooner than the heavy spike, which is just steel. Moreover, the spike gives a much more rigid anchorage."

"It's spikes for us," said the young man, "but tell me, what does our brick veneer wall rest on?"

"IN RARE cases," said Mr. Dinsmore, "the old foundation projects enough to give room for a veneer base. Generally, as in your case, there is a choice between two methods. My preference is an added concrete foundation alongside the old one. It need not be more than eight inches wide, but should go down below the frost line. A less width would serve, but would be hard to dig. The old wall makes one side of the form and

Below: The photographs show, from the bottom upward, metal lath attached with furring nails holding it a quarter inch from the wall and three coats of stucco applied.

usually the earth makes the other, except for the last foot or two. A concrete of one part cement, three sand, and five parts stone or gravel will be ready to build on in a couple of weeks."

"What is the other method?" asked Ada.

"Angle irons fastened to the wood sill of the house. This is criticized in the case of an old high foundation because it makes the veneer overhang and seem to rest on nothing, but I would be more interested in the question whether the sill is sound all along and whether such a base is permanent. If enough care is taken it may be satisfactory. The angle iron should be three by five inches and five-sixteenths of an inch thick. The narrow side should have holes every four feet to take four-inch lag screws, which are screwed into the house sill. The five-inch side of the angle iron stands out as a ledge on which the veneer wall rests. Of course, the bricks are flush with the outside edge, leaving an inch air space inside."

"What can we do around windows, Mr. Dinsmore?"

"There is no difficulty there. Leave the wood sill in place and build under it a sill made of bricks on edge, sloped outward at the rate of one inch in six in order to shed water. The rear ends of the bricks are cut at an angle to fit against the old wall. The lower edge of the brick sill should project an inch or more beyond the veneer wall. A rich mortar and careful work in fitting the new sill are necessary. In some cases metal flashing or oakum calking might be used in the joint. Sills of stone or precast concrete may be used; it is a matter of style and taste. To cover the joint at the sides between veneer and the old frame we nail on a molding strip known as staff bead."

"I guess the top of a window is more of a problem," suggested the young man.

"NATURALLY, since a new support must be provided for the veneer. Here an angle iron or its equivalent is obligatory. We have the angle piece overlap four inches on each side of the opening to rest on the veneer walls. For spans up to four feet and not much weight to go above, three by four-inch angles can be used, while for very large openings the same size that I mentioned for the base should be used and attached to studs every four feet with lag screws. The short span angle does not need to be screwed fast. Of course the space above doorways is bridged in the same manner with angle irons resting on the masonry at each end."

"We have a porch roof. Would the veneer wall be laid upon it to cover the old wall above?"

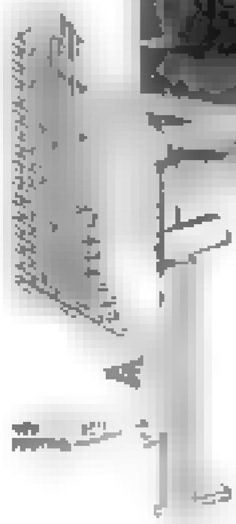
"No, the roof might sag under a weight for which it was not designed. Use angle irons the same size as for the base of the house and fasten them to every third stud with lag screws. We may remove siding so that the angle will rest flat against sheathing. If the roof has a steep pitch there may be a conspicuous gap between the bottom of the angle iron and the roof. We can hide this with a strip of metal flashing that looks useful and sometimes may be so."

"I suppose we can veneer our porch the same as the rest of the house?" inquired Ada.

"Just exactly. Of course, it isn't necessary to warn intelligent people not to veneer a wood floor or wood steps. Use concrete for the hidden part and only enough bricks to cover the surface."

How brick veneer is applied to the upper stories of a frame house. Note the metal plate at lower left-hand corner of photo. Details of method are shown in diagram below

A most ordinary looking frame house, at the right, converted into the charming one below principally by brick veneering, though windows were changed and the second story was squared. Left below: Diagram showing method of veneering.



Photographs by courtesy of the American Face Brick Association

"What about the styles in bond?" asked Donald.

"You are practically limited to one style—running or stretcher bond, in which all the brick except window and other details run lengthwise with the wall. In regular walls of two-brick or more thickness it is simple to make headers with whole brick and to have a wide variety of combinations or bonds. While it would not pay to attempt any of these styles, you can please yourselves in mortar color and method of joints. With a stripped or recessed joint, cracks in the masonry will not show so much as with a joint filled with mortar up to the wall surface."

"I hope we are not limited in the kind and color of brick," observed the young woman.

"NO, INDEED," replied Mr. Dinsmore. "You have a wealth of color and texture to choose from in face brick and a good deal of variety can be had in common brick by mixing the overburned with the ordinary reddish ones. Common brick is forging to the front and is being accepted in the best architectural circles.

"While sizes of brick and of mortar joints vary widely, a rough average allows six and one half bricks a square foot. Measure your walls, deduct openings, and you can find out the approximate number of bricks required. They cost from sixteen dollars for common to twenty-five dollars or more for face brick. As to labor, one bricklayer with a helper will lay about 400 veneer bricks in a day."

"Don will enjoy himself measuring and figuring (Continued on page 129)

Mr. McMahon's articles, a monthly feature, are practical discussions of construction methods that make for permanence and stability, giving you real values when you build. He will gladly answer questions about building problems. Address him in care of Homebuilding Department, POPULAR SCIENCE MONTHLY, 250 Fourth Ave., New York City.

Queer Notions *about* Oil Burners

Here Are the Alarming Tales on One Side and The Facts on the Other Regarding Fire Danger, Noise, Smell, and Dirt

By
JOHN E. LODGE

This sectional drawing shows how a good oil burner, properly installed, automatically maintains any desired temperature and is free from noise, dirt, unpleasant odors, and fire danger.

MISINFORMATION, like bad news, travels both fast and far, gathering embellishments as it goes. That is why people have such queer notions about oil burners.

Here, for example, is a question typical of hundreds presented by readers of POPULAR SCIENCE MONTHLY to the engineers of the Popular Science Institute of Standards: "Is it true that with those burners using an electric spark to ignite the oil there is always the possibility of an explosion?" The question appears in various forms. Sometimes it suggests possible danger from one source, sometimes from another. In fact, almost every component of an oil burner has been suspected of causing fire.

Obviously, no one wants to take a chance on the possibility of a fire from the operation of the heating plant, but if you choose an oil burner that has been listed as approved by the Popular Science Institute of Standards, you can be absolutely certain that there is no appreciable fire risk, no matter what kind of ignition is used or how the burner is built.

In fact, the risk of explosion or fire in the operation of the ordinary coal furnace may actually be greater than with a modern oil burner in which every possible chance for fire is automatically guarded against.

TWO other such questions are: "Does an oil burner cover all the walls and furniture with a sticky black soot?" and "Is it a fact that there always is a strong smell of oil about when you burn oil?"

When oil, or any other fuel, is burned the products of combustion must go somewhere, and if they don't go up the chimney they must spread through the air in the house. But such a condition usually arises from a broken smoke pipe or a plugged up chimney flue, and, whether you burned oil or coal, you would be in for annoyance until repairs were made.

It is true, however, that with a poor oil burner you might get the house full of soot within a week if an incompetent mechanic accidentally set the burner for a smoky flame and in addition did not make sure of an adequate draft in the chimney. But such things cannot happen with a high-grade burner properly installed.

"MY FRIEND says that all oil burners make a loud, rumbling noise that you can hear all over the house. Is that so?" That is another frequently repeated question.

If an oil burner is improperly adjusted it may make a noticeable noise. If the burner is improperly installed in a hot air heating system the noise can be heard throughout the house. But a burner installed by a competent mechanic, and working as it should, is not noisy. And with steam, vacuum vapor, or hot water heating systems, where there are no large air pipes leading to the upper floors, the noises are muffled inside the furnaces. In fact, with the average installation, the noise cannot be heard upstairs unless the house is quiet, and even then you usually have to stop and listen for it.

This statement often appears in our readers' letters: "I have been told that heavy oil fuel contains more heat units, but you can't burn heavy oil fuel without getting into a lot of trouble with carbon."

Oil fuel is the name given to a whole class of materials obtained from crude petroleum. Everything heavier than kerosene and lighter than crude oil is oil fuel, but no oil burner designed for home use will burn, with any degree of satisfaction, oil fuel that reads lower than twenty-four degrees on the scale of the particular hydrometer used to test oils. Some burners require a lighter oil than others, and no reputable oil supply company will quote you a price on oil fuel until you have told them what kind of burner you have.

You can't judge oil fuel by its looks or even its smell. It isn't like coal. The heavier the oil fuel the cheaper it is, and complaints about excessive carbon and smoke undoubtedly originated with people who attempted to burn a heavier oil than their oil burners could handle.

THE problems connected with the storage of oil fuel have given rise to much misinformation. For instance: "They tell me that the oil tank becomes filled with sludge after a while and has to be dug up and cleaned out at considerable expense."

No reputable oil company will sell oil filled with dirt, and there is nothing in the oil itself that could form sludge or muck. A good tank, properly piped, is permanent equipment that will give service for many years without cleaning or other attention.

Prospective oil burner owners have been warned that their fire insurance premiums will be increased when they put in oil burners. If you purchase an oil burner approved by the Underwriters' Laboratories, and it is installed according to their rules, there will be no increase in insurance rates.

In a coming number POPULAR SCIENCE MONTHLY will present important facts as to the cost of oil for home heating as compared with other fuels.

Arrangement for shifting engine crews in transit.

Huge Engine Breaks Record

THESE pictures show the *Flying Scotsman*, the English locomotive that recently made a world's record nonstop run between London and Edinburgh, nearly 400 miles—almost a hundred miles beyond the record made a year ago when the *Royal Scot* inaugurated a nonstop trip between London and Carlisle.

The unique feature is illustrated by our artist's drawing at the left. The leading coach and the engine cab are connected by a corridor extending down the right side of the tender. This enables a fresh engine crew to relieve the tired one when the run is half over without stopping the train. When not at work both crews rest in the leading coach. In the past, nonstop runs have been limited by the endurance of single crews.

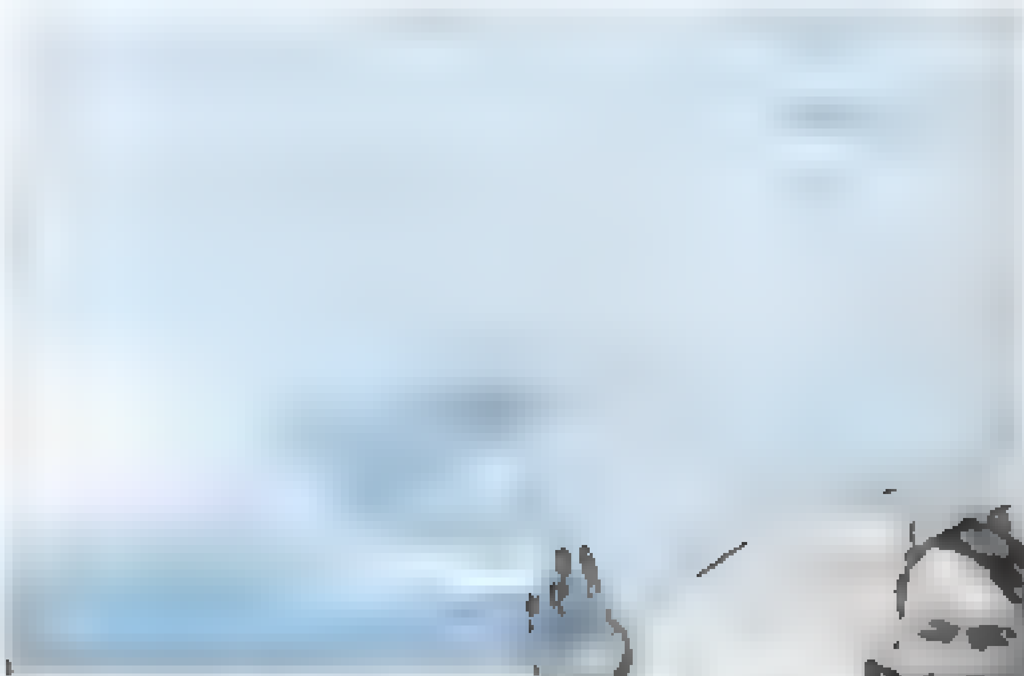
The innovation is made possible by a slight increase in the height and width of the tender and a rearrangement of the coal space. Several similar locomotives are under construction for the nonstop service between London and Scotland on the London and North Eastern Railway.

Malcolm Pope, 18-year-old outboard racer, runs his craft up an incline set in the water at Winter Haven, Fla., and makes the craft do a 35-foot leap. The photographs show the boat at the beginning and in the middle of the leap.

Water Flivvering, New National Sport

Dashing Along at a Speed Of More Than 30 Miles an Hour, Tiny Outboard Motor Boats Break Race Records

By EARL CHAPIN MAY



Kirk Ames in 14-foot Class C *Baby Whale* won the Albany-New York race down the Hudson in 4 hours, 44 minutes, 15 seconds. Pictures taken during and after race

IT SEEMED a shame to accept Dick Pope's challenge to a two-mile dash across a Winter Haven lake. Although Dick was commodore of the Florida Outboard Racing Association, he was also captain, crew, and navigator of a unpainted tub about ten feet long and forty inches in the beam. Dick had made it in his back yard. Mine was a trim mahogany twenty footer with shining brass work and the kind of streamlines you read about.

Moreover, my boat had enough four-cylindered power to drive it easily twenty-five miles an hour, while Dick depended on a portable engine and propeller, fastened to the outside of his boat's stern—an "outboard."

"I owned an outboard twelve years ago," I laughed as we prepared to start. "My arms still ache from cranking it. I know the theory. You spin the flywheel until you, maybe, get a spark, and then your cylinder rotates an upright crank shaft at the bottom of which a propeller whirls. Good bye, my boy, I'll wait for you on yonder shore."

"Let's go!" he shouted, and he went. But at the finish it was he, not I, who waited. "You'd better buck up a bit on motor boats," he said. "Lots can happen in twelve years. So long."

And he spun around and scooted off derisively.

That sad experience made me a discoverer. Like many another water lover I had beheld, without seeing, a marvelous development of minor motor boating for the multitude. Twelve, fourteen, or sixteen years ago the outboard power plant or "portable" was accepted by inland fishermen and rowboat users as an occasional substitute for oars. While an outboard would push a small boat across a lake or on a cruise, it was a "one-lunger"—and a single gas cylinder seldom functions perfectly. But Dick Pope was right. Lots has happened.

Outboard cylinders were produced in pairs. Piston displacement was enlarged. Costly alloys replaced cast iron and common steel. Sealing of coils and condenser casings made magnetos nearly waterproof. Even submersion rarely short-circuited them. Solid units took the place of several parts, particularly at the

Half out of the water and more are these outboard motor craft in a sensational Gold Cup race which held spectators almost breathless at the beautiful Greenwich, Conn., course on Long Island Sound.

When the wind is down or the outing party wishes a rest from manipulating sails, the outboard motor does service on a [illegible] yacht

A moose hunting expedition, made with an outboard motor canoe on Lake Ontario returning to camp with the result of a day's sport

propeller end. Slip-clutches and other shock absorbers protected propellers and saved sheer-pins. Separate feed pipes and cooling system tubes prevented water mixing with the lubricant. Elimination of brass in submerged parts did away with salt sea rust. The slow, shaky, noisy, temperamental motor disappeared so generally that "outboard" became almost synonymous with "reliability."

It certainly became synonymous with "speed." From an official 1925 record of about thirteen miles an hour, outboard speed had reached more than thirty miles this year. So carefully did outboard engineers determine the best bore-stroke ratio, most efficient compression pressure, correct size and timing, dimensions of pistons and curvature of intake passages, and minimum weight commensurate with safety and continuous service, that outboard motors developed in some cases more measured brake horsepower per cubic inch of displacement than airplane engines.

A modern one-cylindered outboard motor weighing about twenty-five pounds will register 3,000 revolutions a minute instead of the old-time 1,300; a twin-cylindered motor, three horsepower with 3,500 revolutions. But heavier twins will develop eleven horsepower, and there are "quads" weighing nearly one hundred pounds that will travel thirty-five miles an hour through still water. Such motors cost from $100 to $175 each.

Many experiments showed that no matter how powerful the motive force, an ordinary displacement hull could be sent ahead only so fast, for an increase in power would merely make it dig deeper into the water. New models then came into vogue—the hydroplanes, flat-bottomed craft that at high speed rise and skim along the water. Single hydroplanes have one continuous bottom without a break from stem to stern. Step hydroplanes, which are often faster, have a break or step across the bottom either amidships or toward the stern. Still others have two steps, generally one near the middle. All steps are at right angles to the keel line, and are seldom more than three inches high. Since such hydroplanes "ride on their tails," the form of bow or stern is not important.

The outboard fan buys these boats from factories at from $150 to $250, but thousands of fans make their own.

Probably nine tenths of the hundreds of thousands of outboard devotees get their greatest pleasure from cruising in small hydroplanes, rowboats, or canoes. Any craft that floats is more or less adapted to outboard motoring.

For the small fishing boat the outboard motor makes an ideal labor-saving substitute for old-fashioned oars.

Left: Uncle Sam gives a new pleasure to an English couple, seen on the Thames in a rubber boat with an American outboard.

The artist and author, G. H. Mitchell, starting from the picturesque Ontario hamlet of Penetanguishene, with an outboard on an eighteen-foot canoe, explored a hundred miles of Georgian Bay's eastern shore as far as Parry Sound, fishing and camping as he went. Prying themselves loose from business cares, Franklin Dunn and Herbert Wendt of Detroit traveled by Lake Erie steamer to Buffalo. Then in a sixteen foot clinker-built rowboat with a twin-cylindered motor they purred and locked through the Erie Canal and followed the Hudson and Harlem rivers to Long Island Sound and the Gold Cup regatta at Flushing, N. Y. They averaged seventy-five miles for each ten-hour "working" day, and slept in a shelter tent. Each gallon of gas carried them fifteen miles.

Paul and Phil (Continued on page 110)

Fortunes from Magic Logs

How Daring Men Face Beasts, Reptiles, and Savages of the Jungles to Bring Back Bits of Wood

G. Proctor Cooper, who battled the Panama jungle to wrest from it two logs of "magic wood."

OUT of the jungles of western Panama, G. Proctor Cooper, a Yale forestry expert, has recently brought two logs of one of the rarest woods known to man. It is a strange ruby and black wood that bursts into a golden sheen when placed in the light. The half wild tribes of the tropics credit it with miraculous curative powers. They call it "magic wood."

Vague rumors of its existence had drifted from time to time from the Bocas del Toro district. But only one fragment, no larger than a man's finger, obtained from a native who could not tell where he had found it, had reached civilization.

With this bit as a clue, Cooper set out on a seemingly hopeless quest. There followed an odyssey of tropical hardship that must rank with that of the legendary conquistadors who marched with Pizarro on his conquest of Peru.

From the beginning, Cooper followed a trail studded with reverses. His pack mules were caught in a landslide. His guides pointed out every log but the right one. His axmen deserted him. He had to traverse steaming jungles and climb rocky mountain paths until his shoes dropped from his feet. He forded swollen, treacherous streams. He waded—sometimes shoeless—knee-deep through yellow, slimy mud until he dropped exhausted and slept in the mud and water. He braved the fever, the biting, poisonous insects of the tropic night, and the venomous snakes of the jungle. *But he found the magic wood!*

By FRANK PARKER STOCKBRIDGE

Beside two rotting logs, his long trail ended. For the strange wood he sought, the Bloodwood Cacique (pronounced Kah-see-key), comes not from live trees but from rotting chunks in the forest. It is the almost imperishable heart of the fallen trunk that remains after ants and worms have burrowed through the bark and sapwood.

"THERE is something uncanny," said Cooper in describing the moment of his discovery, "about stumbling on a rotten log in a tropical undergrowth and with a stroke of the ax through the moldering litter laying bare the deep red of one of the rarest woods in the world!"

Yale University will receive one of these logs. The other will be exhibited at the Field Museum of Natural History in Chicago. Besides these Cacique logs, Cooper's trip yielded several hundred other specimens. When these are examined and classified, they may reveal species hitherto unknown.

This stirring search for legendary timber forms but a single epic in the annals of an adventurous little known fraternity—the rare wood hunters.

As this goes to press, far down in the vast hinterlands of the Guianas and the Orinoco delta another adventurer of the same fraternity is seeking other hardwoods of the tropics. The timber he will bring out to the seaport will be transported to this country by the American Society of Mechanical Engineers. It will be cut into test samples and sent to the forestry department of the University of Michigan for examination. It is hoped that these tests will reveal that for certain engineering purposes some of the new wood is superior to any now in use.

The other day, I had the good fortune to meet one of this sparse and unsung company who brave the dangers of the wilds for precious timber. It was on an East River pier in New York City, where the *Cornelo*, the *Troja*, and the *Aucon* were discharging cargo.

THERE was the smell of the tropics about the ships—an exotic atmosphere that their very funnels exhaled—and their cargo was logs, balks, and timbers of strange, rare woods from the ends of the earth, the sound of whose names suggested high adventure. Amaranth, bethabara, padouk (they call it Corail d'Afrique, too), cocobola, lignumvitae, Gonzalo Alves, prima vera (that means "springtime"), palo de sangre, curarere, peroba, balsa, Pernambuco—the words savored of the Spanish main and the Ivory coast, of strange tribes lurking in dim forests by unknown rivers, poisoning wells to kill the white man or shooting him in ambush with poisoned arrows.

The quest of rare and beautiful woods has led adventurers [illegible] long and dangerous [illegible] corners of the world ever since Hiram, King of Tyre, brought cedar of Lebanon and algum trees to build King Solomon's temple. Clayton D. Mell, free lance hunter of rare woods, is one of these. When

Cooper expedition fording a jungle river after finding the only two magic wood logs ever brought to civilization, carried by the second mule. Above: Prof. S. J. Record, whose clue started the hunt.

he talked to me, his ears were still ringing with the quinine with which a hospital had stuffed him—for he had caught the fever in Nicaragua on a hunt for a rumored forest of lignum-vitæ, growing in the dry bed of an ancient lake.

"I found them," Mell said, "but getting them out will have to wait till the revolution is over. (I had trouble enough getting two hundred tons from Lake Managua, only fifteen miles from the town, down to the port, Corinto. But the marines have built a road that will make the hauling easy when the time comes."

A world-wide shortage of lignum-vitæ had sent Mell on his twenty-sixth tree-hunting trip to the tropics. Le Havre, the world's great rare wood auction mart, reported not a ton to be had. A ton isn't much. A standard six-foot log twenty inches thick weighs a ton and a quarter and sells at $125 to $175.

Most people see lignum-vitæ only in bowling balls and carpenters' mallets and boys' tops; but its big market is for bushings for the stern-post bearings of big ship propellers. A self-lubricating bearing of lignum-vitæ—full of natural oils, impervious to sea water and ship worms, neither swelling nor shrinking—will outlast three of steel. Early clock-bearings made of this self-lubricating wood are said to have run 100 years without oiling.

"IT'S going," said Mell. "We can't get any now except from Nicaragua and Panama. It takes 250 years for a tree to grow to two feet thick. Here's a log"—he pointed to one just swung from the hold of the ship—"that was mature when Columbus landed."

And Mell knows his tropical woods. He took up tree hunting for commerce only after eleven years in the United States Forest Service and after writing the standard authoritative book on hardwoods, this in collaboration with Professor Samuel J. Record of the Field Museum and Yale University School of Forestry.

The rare woods in which Mell specializes are obtained only a few tons at a time and sometimes only a single log—but this may sell for several thousand dollars. The price depends on the quality and beauty that are expected to be revealed when the log is cut into veneers. Some buyers for furniture manufacturers have an uncanny ability to determine at a glance the quantity and beauty of the veneers a certain log will produce. One such buyer is known as "the man with the X-ray eyes."

Buyers may pick their own logs on the pier and direct all operations to and through the mill in order to get the greatest value. The standard veneer is a twenty-eighth of an inch thick, but some are as thin as one hundredth of an inch. A single $1,500 stump of burled American black walnut has yielded 4,400 square feet of veneer.

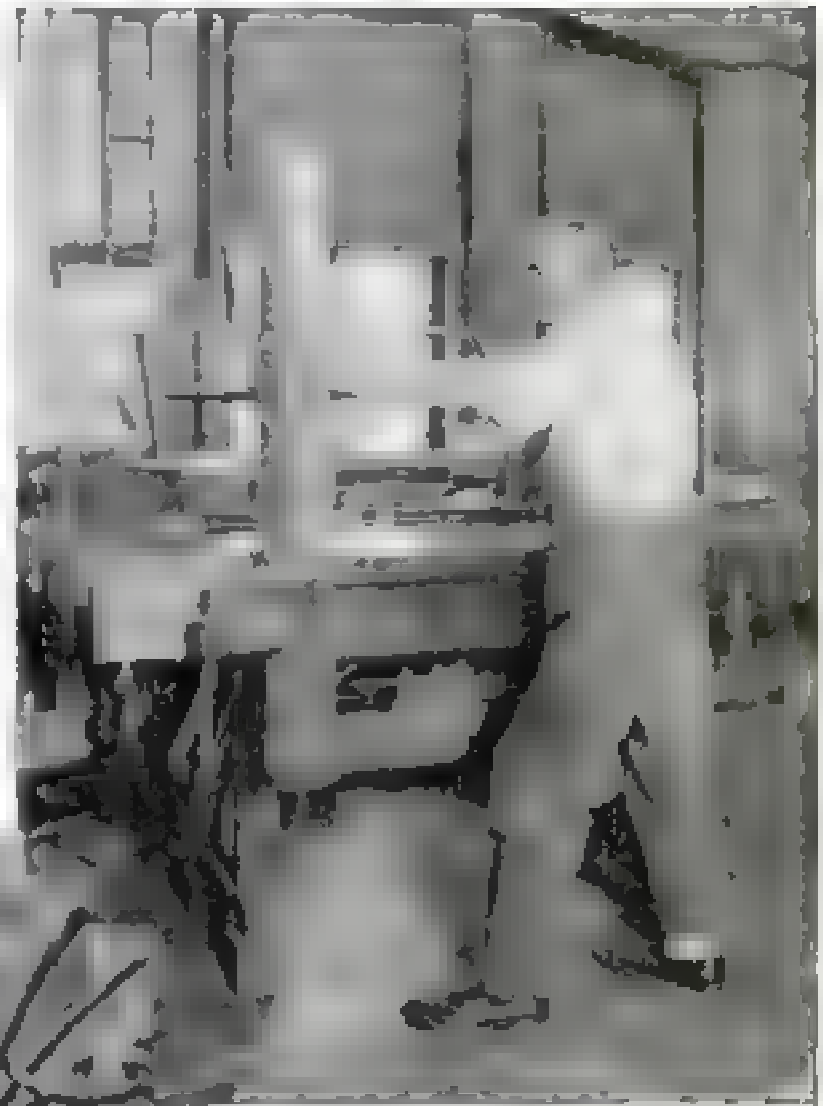
Furniture woods are generally used only as veneers, but other curious woods are used solid for interesting purposes. For example, the reddish brown cocobolo rivals the rosewood in hardness and beauty. But its crowning matter is immersible in hot or cold water and it will not split, warp, or check. Hence it is most useful as handles for knives and other kitchen ware.

"My last trip for cocobolo was to Panama," said Mell.

Gathering cocobolo for knife handles in Panama. Natives resent the white man's cutting the wood, but gladly sell it to him for calico and tobacco

"The trees grow singly and are widely scattered through the forest. The Indians put all sorts of obstacles, including death, in the way of white men who try to penetrate their country. I make up a party of ten or twelve and establish camp on the edge of the forest, then I buy wood from the natives, paying them chiefly in calico and tobacco."

As we moved down the pier, Mell pointed out other pieces, timbers such as men who know the speed and fascination of rare woods travel half around the world and risk their lives to obtain.



Preparing Bloodwood Cacique log for exhibition in the Field Museum. This rare ruby and black wood shines in the light with a golden sheen

"Here is balsa." He picked up easily a fairly large timber that looked as if it would tax the strength of four men to lift. "It is the lightest wood in the world and grows from sprout to maturity in five years in Ecuador. It is used to pack acetylene gas tanks, for it absorbs a great amount of gas under pressure and releases it when the tank valve is opened. It is a great insulator, too. Yeast manufacturers line their shipping boxes with it because it reduces weight and freight costs and also protects the yeast against extremes of heat and cold. Nowadays some balsa is used in radio loudspeakers."

Clayton D. Mell, rare wood expert, discoverer of a cache of cypress logs cut by the Spaniards in Mexico more than four hundred years ago and still sound.

A piece of lignum-vitæ cut after the tree had been growing for more than 250 years, starts out from Nicaragua for the United States.

ROSEWOOD, once the principal material for fine piano cases, has largely been supplanted by veneers. "There is still a market for it," Mell told me, "but not enough to warrant fighting our way into Brazilian forests, where most of it grows. We wait for the local traders to bring it out. We get a thou-

(Continued on page 128)

Making *Street Cars* Noiseless

Lead and Rubber Shock Absorbers and Asphalt-Sealed Rails Make New Vehicles Glide Like Boats

By ARTHUR A. STUART

THE time-honored street car, which seemed to have fallen somewhat behind in the procession of modern inventions, has just gone through a major operation. It has had its noises and jolts extracted. Modeled anew, it reenters the race against its rubber-tired rivals.

On the streets of San Francisco six new cars, padded with shock absorbers from wheels to floor, recently made their appearance on rattle-proof trucks. They are said to have won a joyous welcome, and others will follow.

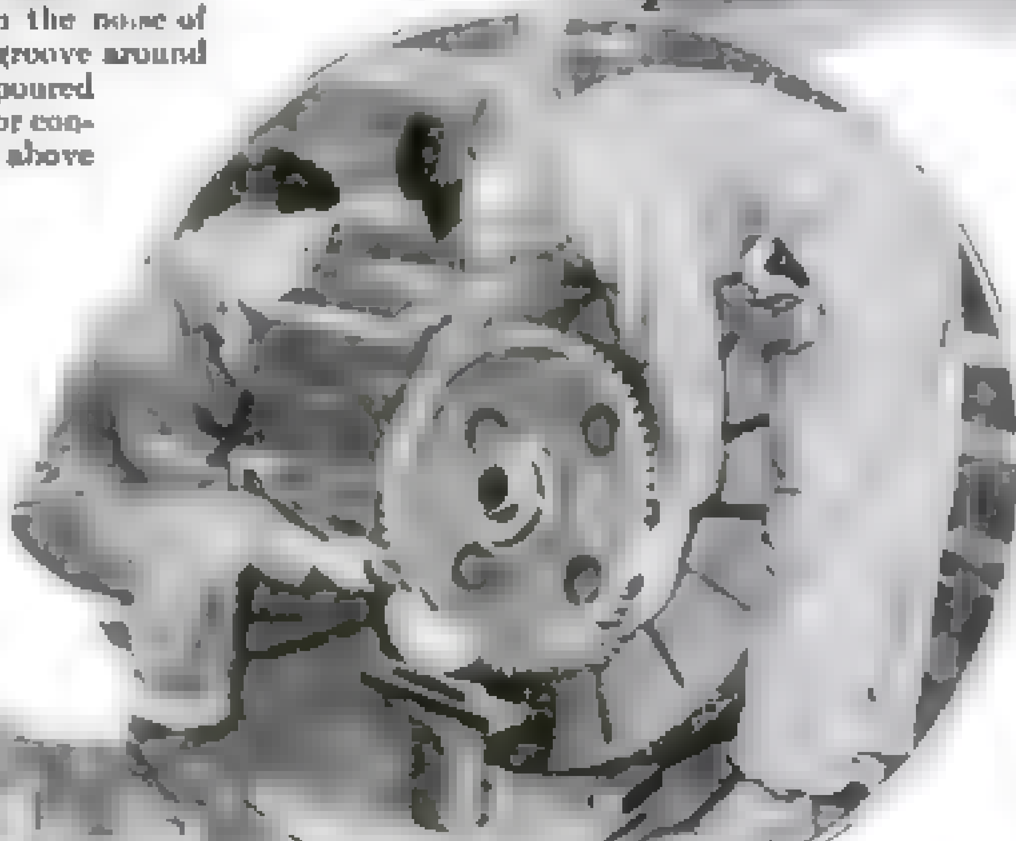
In the shops where these up-to-the-minute vehicles were built, experts employed ingenious methods to dampen jarring vibrations and muffle nerve-racking noises. To deaden the noise of grinding gears, they cut a groove around the inside of each gear and poured it full of lead, which is a poor conductor of vibrations. Then, above the bearings, where the wheel trucks join the body of the car, they inserted shock-proof rubber pads to insulate against jolts.

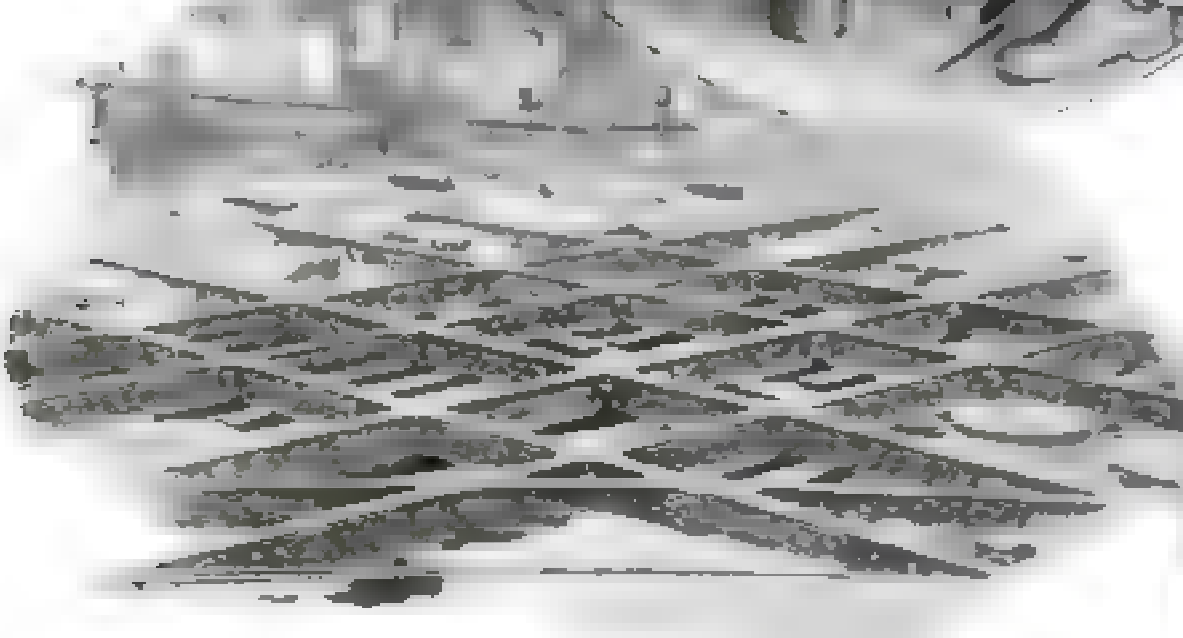
Other rubber pads were placed between the body and frame. To further prevent vibration of the trucks from reaching the passengers, they placed a heavy layer of feltlike insulating material under the entire floor of the car. Even thumping air-brake pumps were insulated with the same material.

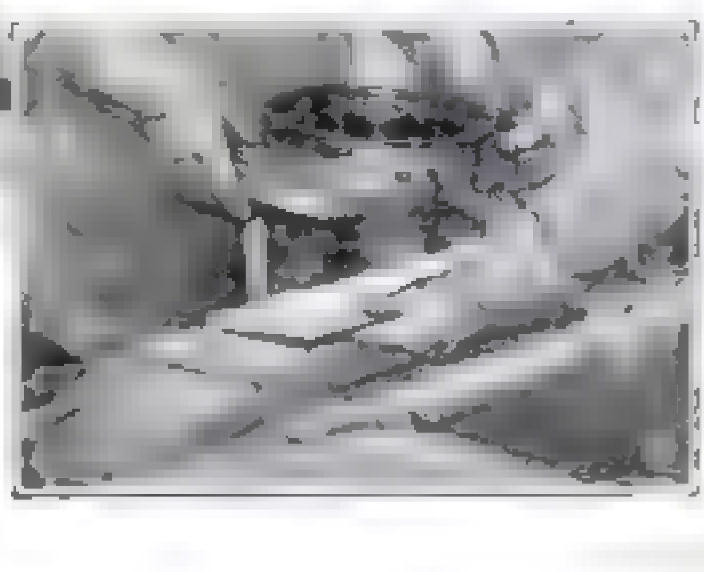
Finally, for a thorough silencing job, an engineer devised a new type of rail crossing which, it is claimed, prevents the pounding noise of wheels as they pass over it. The secret lies in sealing and reinforcing the intersecting rails with asphalt.

Officials of the San Francisco street railway company declare that passengers can ride in the new cars almost as smoothly as in a taxi-limousine. The ingenious improvements, pictured on this page, not only will add to the comfort of riders, but will help to rid the city of one contributing cause of nerve-trying noise and hubbub.

Placing layers of thick rubber pads between the floor of the car and its outer frame. Upper photo shows the thickness and number of these pads.







Eliminating the noise and jar where tracks cross each other by sealing and reinforcing the intersections with asphalt. This, it is claimed, quiets the nerve-racking sound of wheels bumping over joints. Above: A groove cut in the master gear, as well as all others, is poured full of molten lead, which, being a poor conductor of vibrations, makes the car run less noisily. Right: Putting rubber pads between center bearing and truck bolster to save car from motor vibrations.

Alfred Lee Loomis and the two worlds he lives in: the feverish market of money, stocks and bonds in the city's throbbing heart by day; the quiet of a splendidly equipped laboratory on a suburban estate in leisure hours.

A Scientist of Wall Street

After a Hectic Day on the Market, Alfred L. Loomis Turns to His Laboratory as a Hobby—How He Discovered Sounds That Burn

By GEORGE LEE DOWD, JR.

IT IS the peak of a rush day on the New York stock market. In the office of the vice president of a large Wall Street banking house, a dynamic, boyish-looking man sits at the throttle of a high-speed machine of finance. About him seethe the hubbub and excitement of the world's money market. Quick decisions, hurrying messengers, the steady grind and chatter of the stock ticker—each moment is crowded with feverish activity.

A few hours later, on a broad estate at Tuxedo Park, N. Y., miles from the city frenzy, this same high-powered business executive may be seen hard at play. In white apron, surrounded by curious test tubes, chemicals, and electrical apparatus, he is taking his recreation—in a physics research laboratory!

The man is Alfred Lee Loomis, physicist; business man of science. The laboratory is his private playground. It is his hobby. Where other men play golf, or putter in the garden, or tinker with tools, for relief from business cares, he turns to his retorts and his experiments.

The Loomis laboratory is known to scientists the world over. For, from his playtime research in collaboration with technical men of note, who accept his hospitality and the use of his fine equipment, have come some of the newest marvels of discovery in physics and biology.

MOST spectacular of these is the production of super-sound—intense "noises" so silent that no human ears can hear them, yet so terrific that they can kill frogs and fishes, or burn your fingers! Through a high-powered microscope, Loomis has seen these waves of silent sound twist and shatter human blood corpuscles into a thousand bits, or hurl cells of living protoplasm into a mad, whirling dance of death.

A fascinating hobby, this—to turn from the rumble of Wall Street to play with "whispers of death"!

It was some months ago that Loomis and Dr. R. W. Wood, Professor of Experimental Physics in Johns Hopkins University, first created the strange "burning sounds." These are sound waves vibrating at the tremendous rates of 100,000 to 700,000 impulses a second. The lowest musical pitch which most people can distinguish has about forty a second. The standard middle C on your piano has 256. The more rapid the vibrations, the higher the pitch. Beyond about 20,000 a second, we can hear no sound, though it has been said certain insects can. Somewhere near the limit of human hearing is the squeak of a bat. Most young people can detect it, some older folks cannot.

To produce waves of super-sound, Loomis and Dr. Wood devised remarkable apparatus of clear quartz, which possesses the unusual property of vibrating (expanding and contracting) in response to high-frequency alternating currents of electricity. (Continued on page 135)

Tuning-In the Short Waves

How to Build a Simple Adapter Unit Which Will Widen the Range of Your Electric or Battery-Operated Set

By ALFRED P. LANE

YOUR radio broadcast receiver is like a horse fitted with blinders. The horse can see only the road in front of him. Your receiver can tune-in only the waves in the broadcast band from approximately 200 meters to about 550 meters. The only difference, in fact, is that the blinders on the horse can be removed or adjusted to widen his vision, whereas a radio receiver cannot be made to receive a wider band with maximum efficiency.

What goes on immediately above 550 meters is of no particular importance to the average radio fan. It is mostly code transmission, ship to shore traffic, radio compass signals, and so on. But on the other end of the wave length band, from 200 meters down, there is a considerable amount of radio transmission that may be of interest to you. Stations such as KDKA in Pittsburgh, WGY in Schenectady, and KYW in Chicago regularly broadcast programs on waves below 100 meters, as well as on their regular waves in the broadcast band. Because of the marvelous carrying power of the short waves, listeners in distant parts of the country often are able to get one of these stations on the short wave with excellent volume, when the station can be heard only weakly or not at all on the regular broadcast wave.

IN ADDITION, all the 18,000 licensed amateur radio operators in this country, and many foreign radio amateurs, carry on their phone and code communications on waves below 200 meters. And if you are a bug on bringing in distant stations, you can, on the short waves, tune-in amateur stations all over the world. Of course you will have to master the code to do this, but as the call letters are repeated many times, usually at a rather slow rate, you do not have to be an expert.

Building a short wave adapter for your broadcast receiver is easy and quite inexpensive. In its simplest and most practical form, it consists of a short-wave tuning circuit plus a single vacuum tube and a special plug that can be inserted in the detector socket of the broadcast set in place of the detector tube. The latter is transferred to the socket in the short wave circuit. By this method you cut out the radio-frequency amplifier stages and the detector stage in your broadcast receiver and substitute for them the plain regenerative short wave detector.

The special short wave adapter in Fig. 4, in use with the POPULAR SCIENCE MONTHLY Electric Set, detailed in our blueprints 79 and 80 or 81.

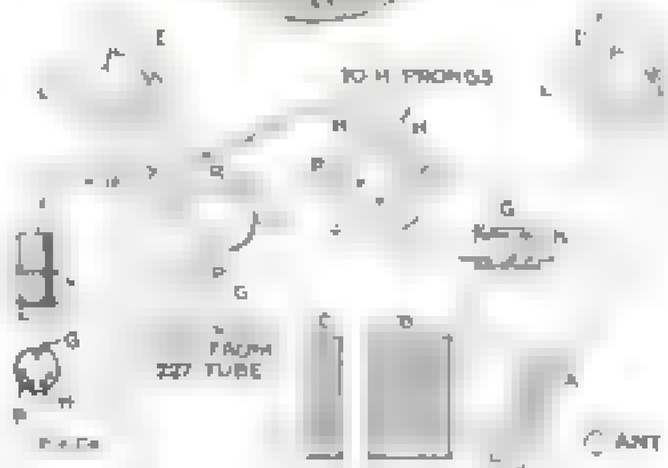


FIG. 2

OF COURSE it is for you to decide as to how elaborate a short wave adapter you wish to construct. The illustrations of Figs. 1 and 6 show the simplest possible construction.

The essential parts you will need depend on the type of broadcast receiver with which the short wave adapter is to be used.

Fig. 1 shows a picture wiring diagram of a short wave adapter for a battery-operated receiver of the usual five or six tube type. Fig. 6 shows the model unit.

To construct this unit you will need a set of short wave coils with a plug-in type of mounting. Plug-in coils must be used, because it is impossible to cover all the wave lengths from fifteen to 200 meters with a single tuning unit.

One antenna coil *A* will do for all wave lengths, however, so that the plug-in units each consist of secondary coil *B* and tickler coil *C* for each wave band. Fig. 5 shows two different makes of short wave coil sets that have been approved by the Popular Science Institute of Standards. The two units in the set at the right include only the four coils needed to cover the band from fifteen to slightly over 200 meters, while the set of coils at the left includes extra coils sold separately, one of which will get down to thirteen meters while the others

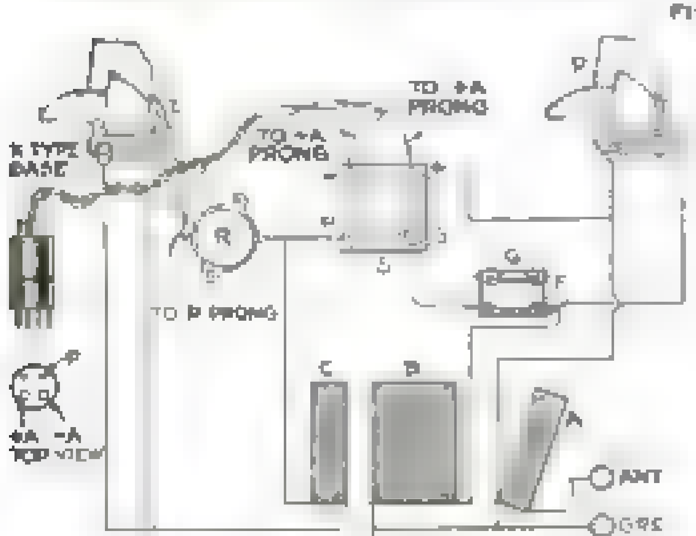


FIG. 1

Fig. 1, at left, shows wiring diagram of a short wave adapter for a five or six tube battery-operated receiver. The model unit is shown in Fig. 6 on opposite page.

Fig. 2, above, shows the same circuit modified for use with electric receivers using the 227-type detector tube.

Fig. 3, at right, shows wiring diagram employed in building the model adapter unit in Fig. 4, for use with the POPULAR SCIENCE MONTHLY electric receiver.

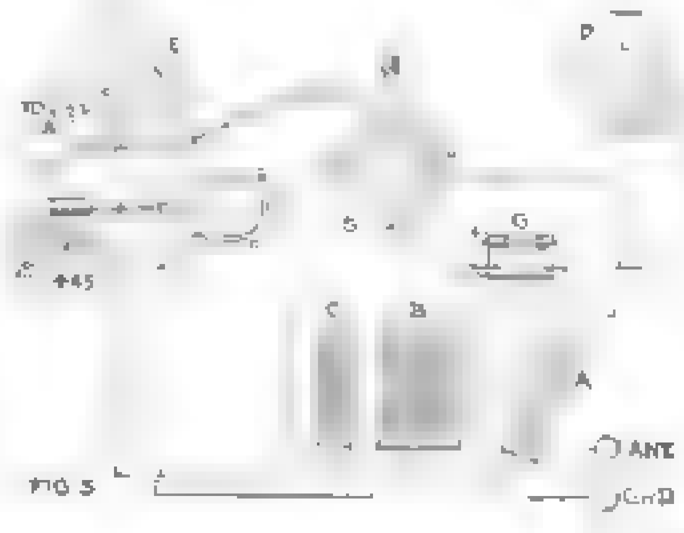


FIG. 3

will tune the regular broadcast band of wave lengths. This particular set would be suitable for the constructor who wanted to build a plain regenerative receiver to cover the broadcast bands as well as the short wave lengths.

D is a standard type of variable condenser with a capacity of .00014 mfd. (usually seven plate), and *E* is a variable condenser of .00025 capacity. *F* is a grid condenser which should be of .0001 mfd. capacity and *G* is a five-megohm grid leak. *R* is a radio-frequency choke coil of eighty-five millihenries inductance. *S*, the socket, should be of the standard X type if the adapter circuit is to be used with a battery operated receiver, or of the five-hole Y type if the unit is to be used with a modern electric receiver.

OF COURSE you will need a panel and a baseboard. A convenient size for the panel is seven by twelve inches. The baseboard should be ten or twelve inches wide so that the coil mounting can be placed back where there will be no metal in the field of the coil.

While it is desirable to use a .00014 condenser at *D*, as the coils are designed to overlap with this condenser, you can use a larger capacity such as .00025 or even .00035. You will be able to get the stations just as well except that the tuning will be so sharp that you will have trouble in getting an accurate adjustment. And the higher minimum capacity of the larger condenser will prevent you from tuning to as low wave lengths as is possible with the proper condenser. Do not use a smaller condenser than .00014, as it would so reduce the wave band covered by each coil that there would be gaps in the wave band that you would be unable to tune-in.

THE capacity of condenser *E* is not so critical. When everything is just right you will not need to use the full capacity of a .00025 condenser. Under such conditions a .0001 variable condenser can be used and, in fact, a condenser of this capacity was actually used in constructing the model unit shown in Fig. 6. Since the excess capacity does no harm, however, it is better to use the recommended size of condenser such as was used in building the special unit shown in Fig. 4.

Readers who have built the one-tube radio receiver described in POPULAR SCIENCE MONTHLY Blueprint No. 41 will at once recognize its similarity to the short wave circuits shown on this page. The arrangement of the apparatus is the same, and the circuit is also, except for the addition of the radio-frequency choke coil and the necessary changes to allow for a plug-in circuit.

Blueprint 41 will, therefore, prove useful if you are a beginner and wish to construct this short wave circuit for separate battery operation for headphone use on the broadcast band of wave lengths as well as on the short waves. The blueprint will show you how to complete the battery wiring and connect up a jack for the headphones. Of course, if you want loudspeaker operation and you have no radio receiver with which to connect a short wave adapter of the type shown here, you can build a detector tuning unit in combination with the audio amplifier detailed in Blueprint No. 42.

FIGURES 1 and 6 will show you how to build and wire the short wave adapter if you have a radio receiver that uses battery type tubes, either 201A for six-volt operation or 199 for dry cell operation. The use of a B-eliminator does not alter the circuit in any way.

Figure 2 shows the same circuit except that it is made up for use with electric receivers using the 227-type detector tube. The only difference between this circuit and that in Fig. 1 is that a five-hole socket suitable for the 227 tube is used and the grid return wire, the one that branches off from the wire that connects to the rotary plates of condenser *D*, is connected to the K terminal of the socket instead of to the plus filament terminal.

As noted in Figs. 1 and 2, the plug to be inserted in the detector socket of the radio receiver while the short wave adapter is in use is made from the base of a discarded tube. The standard X-type base is used for battery-type receivers, and the base from a burned-out 227 tube is used for electric sets. In either case the glass is broken and the cement removed from the base, after which you can touch a soldering iron to the ends of the prongs and substitute the wires from the short wave adapter for the leads to the elements of the discarded tube.

Figures 1 and 2 show which prongs are connected to the wires. Braid the three wires together as shown in Fig. 6.

IF YOU have constructed the POPULAR SCIENCE MONTHLY Electric Set detailed in Blueprints 79 and either 80 or 81 you should follow the diagram in Fig. 3 in building the model unit shown in Fig. 4. This arrangement has been specially worked out in the Popular Science Institute of Standards laboratory to avoid the necessity of removing the detector tube and to make it possible to shift instantly from short waves to the broadcast band or vice versa.

The illustration at the top of page 44 shows this special short wave adapter in use with the POPULAR SCIENCE MONTHLY Electric Set. As you will note by comparing Fig. 3 with Fig. 2, there is no difference in the circuit except in the method of connecting the adapter unit to the receiver. Instead of using a plug made from a discarded tube base, the two-and-one-half-volt wires should be permanently clamped to the two-and-one-half-volt binding posts in the power amplifier and current supply unit, in parallel with the wires that supply two-and-one-half-volt current to the detector in the electric set. Switch *T* in Fig. 3 is provided so that the tube in the short wave unit can be turned off when the short wave unit is not in use. The wire marked "plus 45" in Fig. 3 should be permanently clamped under the forty-five-volt binding post of the power amplifier and current supply unit.

TO PUT the short wave unit into action, push the plug into the jack on the panel of the electric set (the one regularly provided for phonograph record and voice amplification) and turn on the switch *T*.

The binding post marked "Ground" in a short wave unit built according to either Figs. 2 or 3 should be connected to the ground binding post of the broadcast receiver. Before (Continued on page 133)

Fig. 5, above, shows different makes of short wave coil units approved by the Popular Science Institute of Standards. Fig. 6, at right, is a simple short wave adapter that can be used with battery or eliminator operated receivers.

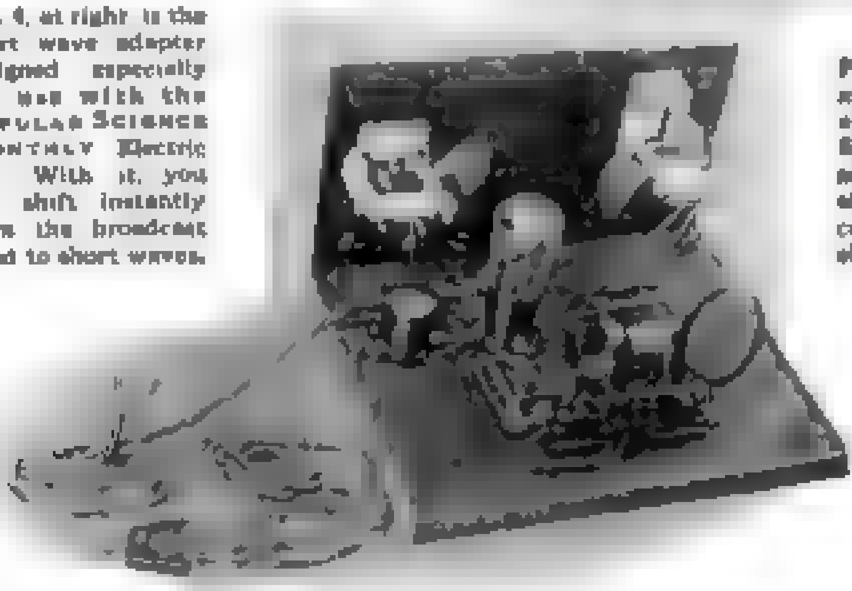
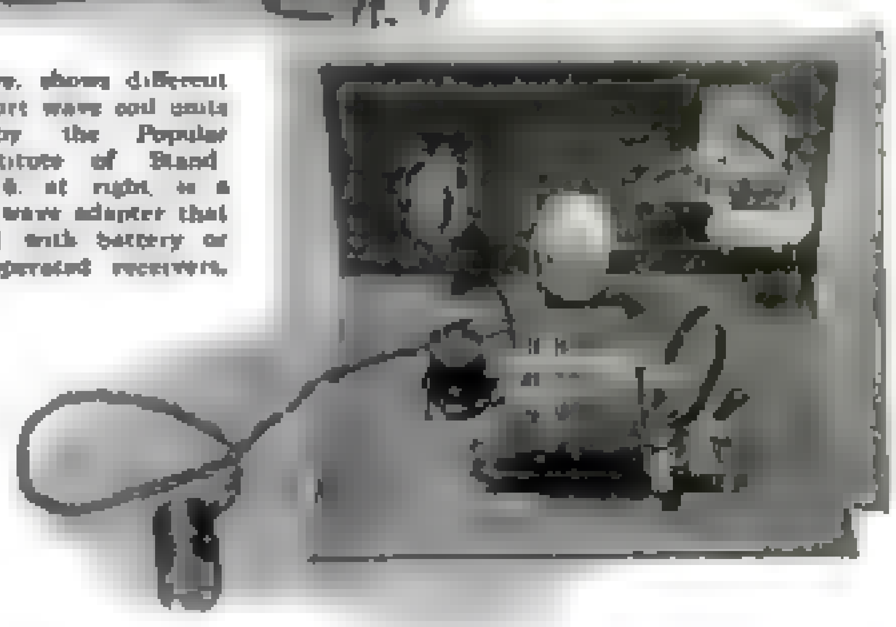


Fig. 4, at right, is the short wave adapter designed especially for use with the POPULAR SCIENCE MONTHLY Electric Set. With it, you can shift instantly from the broadcast band to short waves.



Saving Trouble in Building Radio Sets

Coil Winding Made Simple

Short Cuts for Tyro Constructors—Secrets of Good Dial Fitting

IT FREQUENTLY happens that you want to substitute a tuning coil wound on a smaller or larger form than the one specified in the wiring diagram of the receiver you are building. And then you are faced with the problem of determining the correct number of turns of wire to get the smaller or larger coil to tune to the broadcast band of wave lengths.

Assuming that the specified coil form is three inches in diameter, you will find that the number of turns should be changed inversely in proportion to the change in diameter if the latter does not exceed twenty-five to thirty percent. If, for example, the drawing calls for a three-inch coil with fifty turns, you would need to wind seventy-five turns of wire on a two-inch coil form, or thirty-seven and a half turns on a four-inch form to get the same tuning results. In other words, multiply the number of turns on the specified coil by its diameter and divide the result by the diameter of the coil form you wish to use. Of course, this is not an absolutely precise formula, but it will serve as a useful guide within the one limits specified.

There are many times when you will want to substitute a certain size wire of which you have a supply on hand for a different size specified on the blueprint. This can always be done provided your wire is not so large that the correct number of turns will take up more space than is available.

It is not possible, however, to figure out a really simple formula to give you the change you must make when using different wire.

IN WINDING any coil always make a few more turns of wire than you estimate to be the correct number. The extra turns can easily be removed, one at a time, until by experimenting you strike exactly the right number, whereas if more turns are necessary, you must either rewind or be satisfied with a patched job.

For any given diameter of coil form, the larger the size of the wire you use, the more turns will be required. If the rules call for No. 24 wire and you use No. 22 instead, increase the number of turns. Using No. 26 wire, decrease the number, and so on.

Spacing the turns decreases the inductive effect so that if you wind one coil with each turn close to the preceding one and then wind another coil exactly like the first except that you space the wire so that the turns do not touch, you will find that more turns are needed to get the same results in tuning.

The type of insulation on the wire affects the number of turns not so much because of the electrical characteristics but because the thickness of the insulation affects the spacing between turns.

Three coils of various sizes but of equal inductance because the number of turns also varies.

For any given coil you would have to wind the greatest number of turns if you used double cotton covered wire, a few less if you used double silk covered wire, still fewer if you used single cotton covered wire. Single silk covered wire would require fewer turns than single cotton covered, and enameled wire would require the least of all. Of course this rule holds good only for coils that are wound tight with each turn right against the next one. If the wire is spaced a definite amount per turn, the type of insulation is of no practical importance.

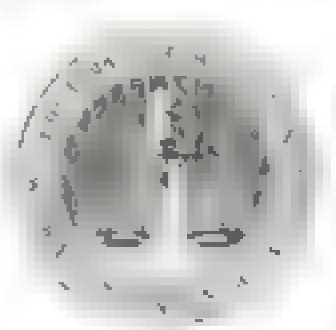
Saving Time in Radio Construction

THE beginner in putting together a receiver often spends more time than necessary on some parts of the work and then, in his hurry to finish, rushes operations that ought to be done slowly and with great care.

Fitting dials to the panel often leads to grief. The beginner is careless about marking the holes, using the paper template as a guide, and then proceeds to drill the holes with a drill exactly the same size as the screws that must be pushed through them. The result is that the holes are out of alignment, the tight fit of the screws allows no leeway, and the thing won't go together. You should be as accurate as possible in laying out the holes and then drill them oversize to be on the safe side. With drum dials that require a piece to be cut out of the panel, make sure that it is a shade larger than is actually necessary. The front plate will cover the hole anyhow. Many dials fitted by beginners work much too stiffly merely because the shaft is binding in the hole in the panel. Of course, the type of mounting must be taken into consideration, but in cases where the condenser is held in place by special mounting screws, be sure to drill the hole for the shaft with a lot of clearance. Use a ½-inch drill at least.

Once the panel is assembled to the baseboard, the beginner often attempts to save time by screwing all the parts in place without first drilling holes so that the screws will go in easier. This is practical only if the baseboard is made of soft pine. With other woods, the screws may stick and break off, the heads will certainly be marred, and in trying to force them in, the screwdriver is almost sure to slip and scratch or break something. Hold each instrument in place while you mark with a pencil where each screw is to go and then drill a pilot hole for it nearly as deep as the screw will penetrate. This method actually saves time and certainly results in a better looking job.

A B C's of Radio



ELECTRICALLY, all condensers are alike. They consist of nonmagnetic metal plates separated by insulation.

The original unit of electrical capacity measurement is the farad. A condenser of one farad capacity would require a current of one ampere flowing for one second to charge it to an electrical pressure of one volt. But the farad is so large a unit that the capacity of condensers is commonly specified in microfarads, one microfarad being a millionth part of a farad. The total capacity of condensers connected in parallel is the sum of their capacities. If they are connected in series and of equal capacity, the total is the capacity of one divided by the total number. When condensers of different capacities are connected in series, an algebraic formula must be solved to get the resulting capacity, but in any case it always is less than the capacity of the smallest condenser in the series.

When *You Buy* a Loudspeaker—

An Article That Tells Everything You Need Know if You Wish To Get the Best Possible Reproduction of Radio Broadcasting

By JOHN CARR

A RADIO loudspeaker is a machine that takes electrical vibrations fed into it from a radio receiver and turns them into sound. It isn't, strictly speaking, a musical instrument. It hasn't any tone of its own unless it happens to be out of adjustment, in which case a raucous squeal or a hollow grunt may be produced.

A loudspeaker makes electrical vibrations into sound waves by utilizing one of the most elementary principles of magnetism—the pull of a magnet on a piece of iron. Of course, there are many ways in which the principle is worked out in the various speakers, but the basic idea is always the same.

You know that when two magnets are brought together, the north poles or ends of the two magnets repel each other, while the north and south poles are attracted to each other. The poles of a magnet are called north and south because if the magnet were suspended in the air by a fine thread, the magnet would always swing around until the same end pointed toward the magnetic north pole of the earth.

Fig. 1. Diagram showing the essential parts of a loudspeaker unit.

PERMANENT magnets are made of hard steel. Soft iron or cast iron will not retain magnetism. But if you wind a coil of wire around a soft iron core and then pass a current of electricity through the wire, the iron core will be magnetized as long as the current flows.

Now if you take a permanent magnet and place close to the end of it a small piece of soft iron around which a coil of wire has been wound as shown in Fig. 1, you have the essential parts of a loudspeaker unit. Passing a vibrating current of electricity through the coil of wire will cause a swiftly changing magnetic pull that will make the small piece of iron vibrate in time with the electrical vibrations.

YOU would even hear music if the electrical vibrations had been produced by music, but the sound would be relatively weak, because the vibrations of the small iron core would affect only the air immediately surrounding it.

Much more volume of sound could be obtained by fastening a short piece of stiff wire to the small iron core with the other end attached to a paper diaphragm as shown in Fig. 2. This illustration shows you, in principle, how the popular cone type loudspeakers are constructed.

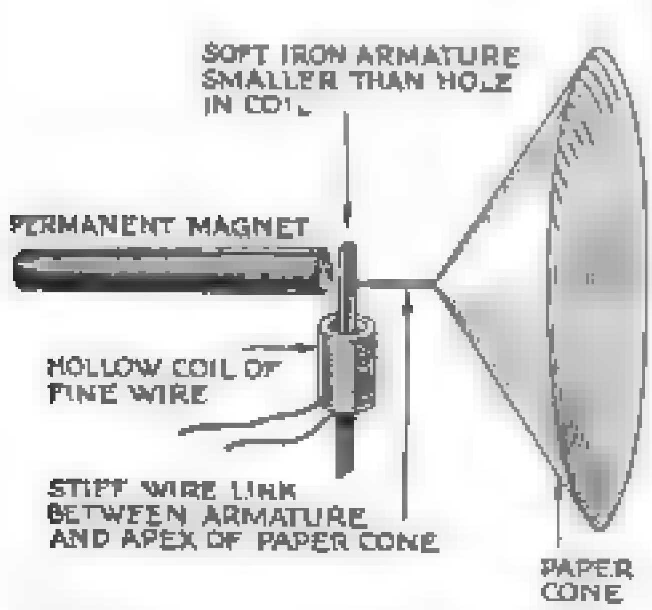


Fig. 2. This diagram shows how simply the fundamental part of a loudspeaker unit could be made into a cone speaker. It would be crude, but it would be built on the same principle as the best loudspeakers made by radio experts.

BUT while Fig. 2 illustrates the theory, you could not construct a loudspeaker unit in this crude fashion with any expectation of satisfactory results. The music or speech would be exceedingly weak as compared with any standard loudspeaker, and the tone quality would be hopelessly poor.

Long continued research has shown the loudspeaker manufacturers how to refine the crude idea shown in Fig. 2 into the highly perfected modern loudspeaker unit, several types of which are illustrated in the accompanying photograph.

Plenty of volume is, of course, a vital consideration; and volume, with any given signal input strength, depends very largely on how much magnetic attraction can be developed from the flow of a given amount of electric current.

By concentrating the magnetic field of the permanent magnet into a small space and by designing the coil so that it will develop the maximum amount of magnetism in the movable small iron piece called the armature, a relatively high magnetic pull is set up with rather weak electric currents. Horseshoe magnets are used with pole pieces clamped to them in such a way that a double magnetic path is provided. Then the armature is hinged at the center instead of at one end, so that the attraction of both ends may be utilized. A typical example of this construction is the speaker unit at the left in the photograph.

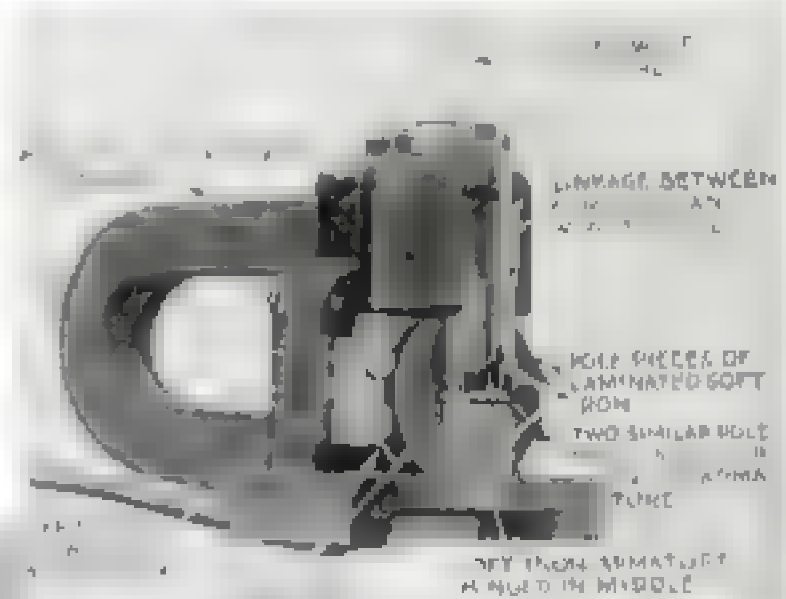
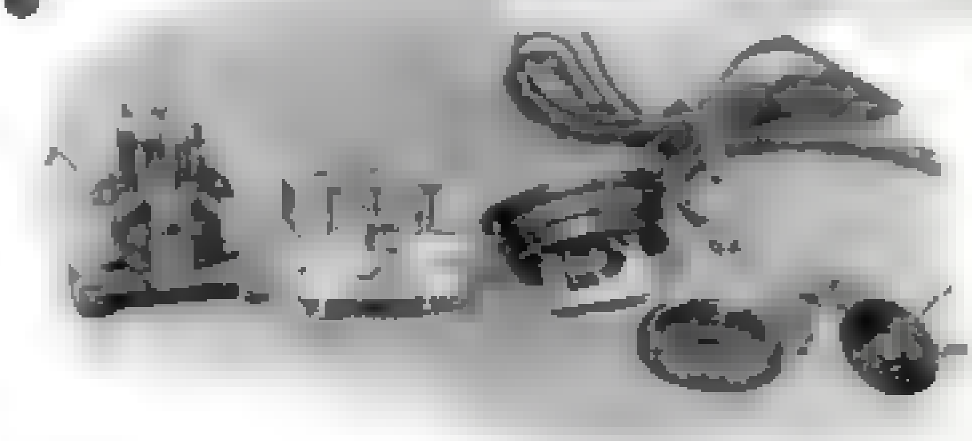


Fig. 3. This diagram shows the complete details of the loudspeaker unit seen at the left in the photograph below.



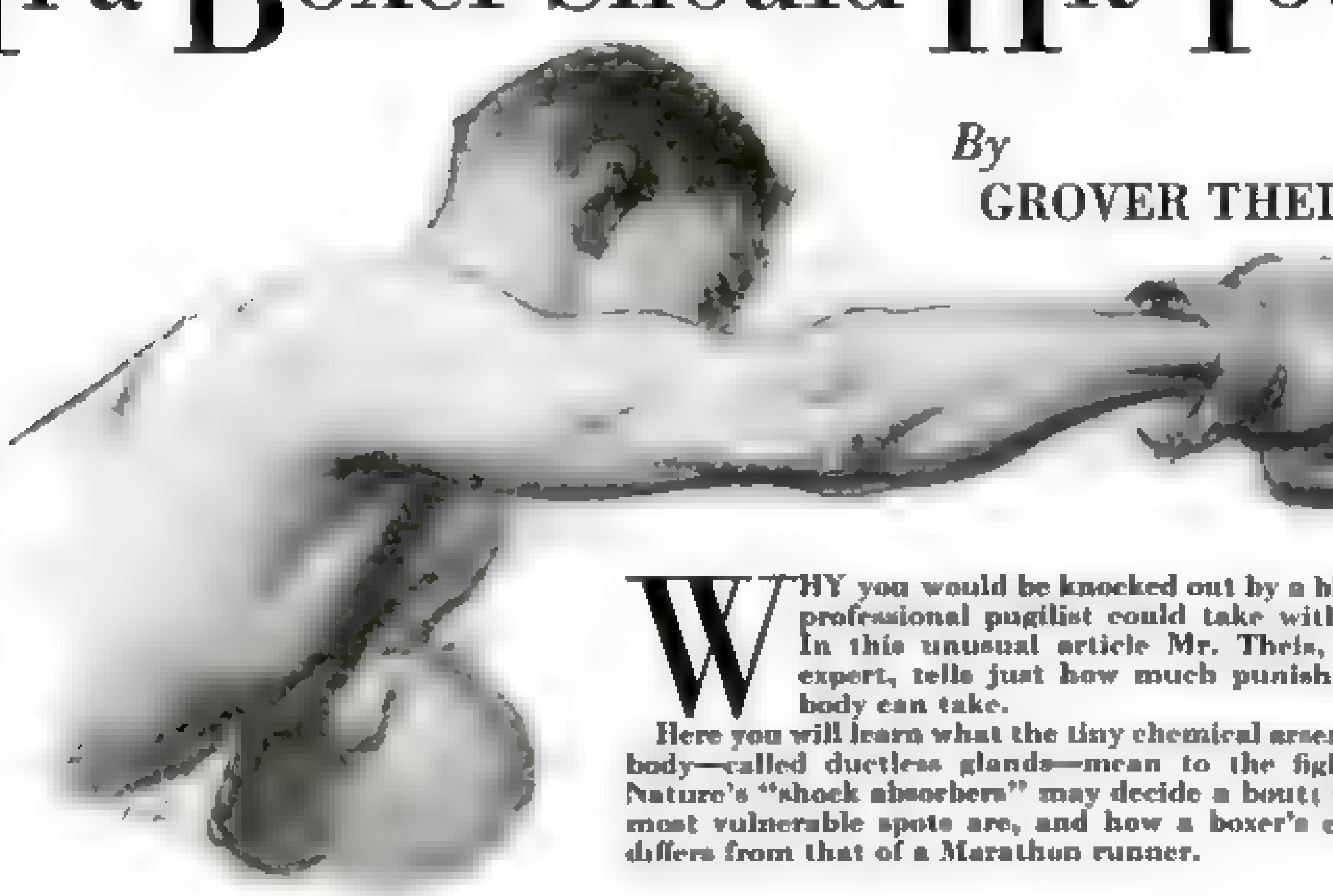
Left to right: High-grade loudspeaker unit; a cheap unit of poor quality; a small unit satisfactory for the use; headphones, forerunners of the loudspeakers used today.

True tone quality is still more vital. And a loudspeaker will give true tone quality only if it is capable of turning into equivalent air vibrations all the different electrical vibrations that are

(Continued on page 127)

If a Boxer Should Hit You—

By
GROVER THEIS



WHY you would be knocked out by a blow that a professional pugilist could take with a smile. In this unusual article Mr. Theis, a boxing expert, tells just how much punishment the body can take.

Here you will learn what the tiny chemical arsenals of the body—called ductless glands—mean to the fighter; how Nature's "shock absorbers" may decide a bout; where the most vulnerable spots are, and how a boxer's endurance differs from that of a Marathon runner.

IN THE ring at Madison Square Garden, New York, two little men—together they weighed only 250 pounds!—stood toe to toe, and with gloved fists battled for the featherweight championship of the world. On one side Tony Canzoneri; on the other Benny Bass. Little fighting cocks, but lithe and strong and crafty as tigers. And how they fought!

Thud! Tony's right hand crashed into Benny's body. The noise of it resounded to the far corners of the big amphitheater. The 14,000 spectators howled.

Plap! Benny's left fist pounded flush to Tony's mouth and nose. It was blow for blow. The mob went wild.

Three rounds passed. Two sleek, athletic bodies took bitter punishment and gave it in return. Then a little piston of muscle and bone flashed upward from Tony's right side. It moved nine inches, and struck. Benny crumpled and went down. The referee began to count—"One, two, three, four, five, six, seven, eight"—Clang! The bell ended the round and saved a knockout.

In his corner, while seconds worked over him frantically with towels and restoratives, Benny complained.

"I broke my hand. It hurts."

"Broke, me eye!" The seconds were unsympathetic. "How could a punch in the jaw break your fist?"

With the bell for the next round, they shoved Benny into the ring. Round after round he waded in to exchange vicious blows that would win or lose a championship. And with each breathing spell between rounds he complained of his "injured hand," only to be greeted with the cynical reply, "Bunk," and sent back in again.

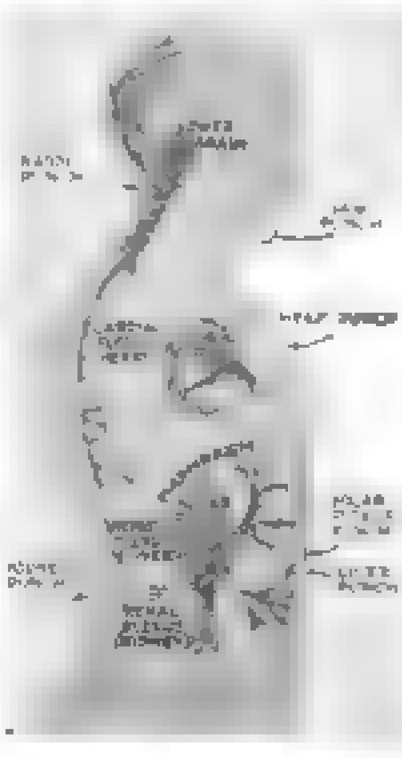
IN THE eleventh session he rushed with a fury that sent his opponent against the ropes. The crowd was in uproar. But the rally was not enough. After fifteen rounds of one of the greatest featherweight battles in recent years, Tony Canzoneri was proclaimed champion—by a hairline decision.

Six weeks later, visiting the office of Dr. W. G. Fralick, noted specialist on injuries to boxers, I found the surgeon removing a plaster cast from the shoulders of Benny Bass. And I learned that from the fourth to the fifteenth round of that whirlwind battle the little chap who complained of a "broken hand" had fought doggedly on with a shattered collar bone!

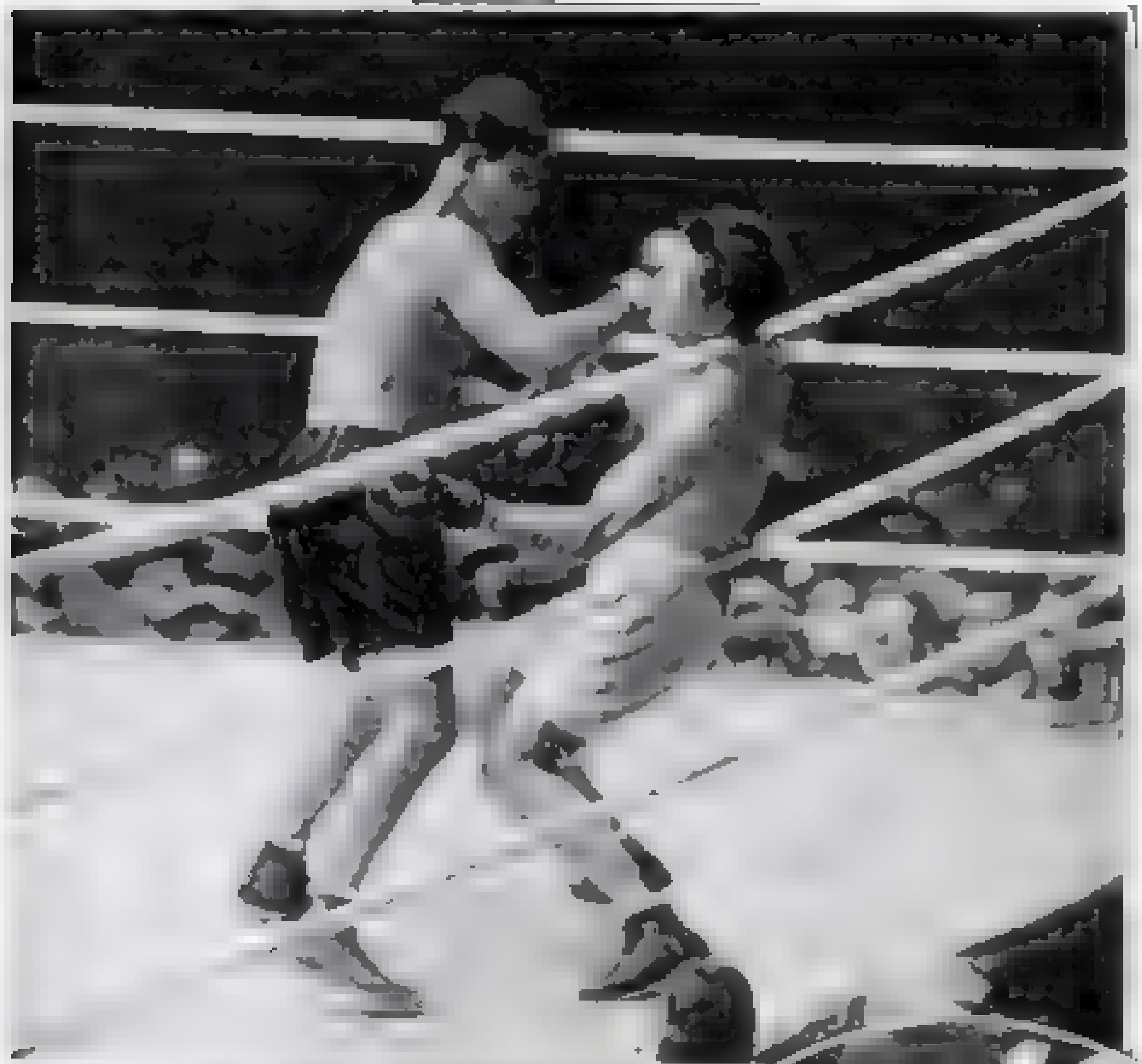
How could he do it?

"How on earth can they stand it?" you have asked more than once as you have listened over the radio to the detailed description of blows given and taken by champions. Sledgehammer fists crash against a stone wall of human flesh. Either fists or human wall, you say, must surely break. Yet, amazingly, both survive. Until perhaps a well calculated blow finds a vulnerable spot, and one fighter goes down. Even then, does he stay down? Not always.

You recall the great battle, some months ago, between Tommy Loughran, light heavyweight champion, and Leo Lomski. Twice in the first round Loughran was floored by a rain of blows to the head, and each time he was down for a count of nine. Yet the champion not only got up and returned to the fray, but outboxed and outpointed his opponent for the remaining fourteen rounds. And after it was over, Loughran confessed that he could not remember anything that happened during four rounds following the two knockdowns. For those rounds



THE chart at the left shows the blows that are most dangerous to a boxer and explains the reasons by giving the positions of the nerve centers that these blows affect. The jaw punch jars the lower brain, suspending the sense of balance and may temporarily paralyze the nerve centers, causing uncon- [redacted] The rabbit punch—at the back of the neck—has similar effects. The solar plexus punch temporarily stops most of the bodily functions, including breathing and muscular control. The kidney, liver, and heart punches produce the same effect as the solar plexus punch. The fighter is not knocked unconscious, but due to his temporary loss of muscular control is unable to rise. The most destructive blows probably are those to the jaw and the solar plexus.



Jack Dempsey sending one of the succession of battering-ram blows that floored Gene Tunney at Chicago. Any one of these blows would have knocked out the ordinary man. Still, yet Tunney was able to rise, win the fight and keep his heavyweight championship

he had fought on, "dead on his feet."

Such a display of stamina, courage, and fighting intuition—and it is not uncommon in the history of boxing—seems all but superhuman. It is a mystery that students of the human mind and body are only now beginning to comprehend. It is the thing which—all commercial considerations aside—undoubtedly makes boxing the greatest of all sports.

I HAVE talked on the subject with athletic trainers, physicians, psychologists, and anatomists, and most of them agree that boxing, of all sports, exacts the most in real athletic physique, skill and prowess. A boxer, to be of championship caliber, must combine the endurance of a Marathon runner, the agility of a tennis player, the skilled timing and judgment of a baseball star, the speed and alertness of a hockey player, and the nimbleness of a toe dancer. And besides all these, he must have an abundance of that mysterious quality commonly called "fighting heart."

How are such champions made? In a sense, they are not made at all, but born. Especially is this true when we come to the first essential requirements—the so-called fighting instinct, and the ability to withstand punishment. These elusive qualities, science has found, are not acquired primarily by training. They are natural products of the wonderful chemical factories in the human body. Some men possess much of them; others very little. The reason for this goes far back into history. Primitive man in the jungles was surrounded by powerful enemies. As a means of self-preservation, Nature supplied him with little chemical arsenals—endocrine or ductless glands. At the approach of danger these stores released their chemicals into the blood, steeling and stimulating the muscles to instant flight or combat. They doubled his strength and endurance.

Seconds of superb agony: Gene down for the "long count."

This marvelous chemical mechanism survives today in greater or less degree in every man. Very recently Dr. Charles E. de M. Sajous, Professor of Endocrinology at the University of Pennsylvania, told of the discovery of three of these chemicals of the body and how they act to make billions of tiny muscle fibers contract or relax. One of them, he said, proves to be the active basis of adrenalin, the wonderful gland extract which has aided in restoring people apparently dead.

With advancing civilization, however, and the removal of many of the perils that beset men, the response of the body's chemical mechanism has grown sluggish in most of us through disuse. Generations of easy life, comparatively free from hardships and danger, have made men "soft" and incapable of quick response to physical emergencies. Among the outstanding exceptions are the "born fighters."

Jack Dempsey is one. Anyone who witnessed his historic battle with Louis Angel Firpo will agree that only inborn fighting instinct and fighting toughness could have carried him, snarling, back into the ring to beat down the "Wild Bull" who had sent him crashing through the ropes.

GENE TUNNEY is another. In his first fight with Harry Greb, Tunney was punished so unmercifully that he later collapsed in his dressing room, yet Greb was unable to knock him off his feet. And in the famous seventh round in Chicago, when Dempsey had beaten him down with a savage rush, and when a knockout seemed inevitable, Gene was able to come back. With this article is reproduced a "close-up" of Tunney while he was down for that famed "long count." If ever pain and agony were written plainly on a man's face, it is in that picture. Nevertheless, he got up and won his fight. Did courage or the will to win alone do it? I doubt it. I attribute it largely to his naturally tough fiber, and that without reflecting on Gene's pluck.

Any trainer will tell you that the most skilled boxer in the world, unless he has the ability to "take it," has not much chance of gaining the top. There's Jack Sharkey. A year ago he was regarded by many as the next heavyweight champion. Only twenty-four years old, he was a fine physical specimen, and a highly skilled "gymnasium" boxer, yet in ring combat the aging and fading Dempsey knocked him out. Young Jack could have given old Jack boxing lessons; yet the younger and cleverer man simply could not stand up under the bludgeoning blows that Dempsey rained on his midsection.

On the other hand, Tom Heeney's ability to shake off the effects of the heaviest punches and plunge to the attack carried the rugged Australian to the position of challenger for Tunney's heavyweight title.

AGAIN a giant frame and bulging muscles are not enough to make the greatest fighters. See how the overtowering giant, Jess Willard, crumpled before Dempsey's rushing onslaught at Toledo. Some time ago Gene Tunney, writing in POPULAR SCIENCE MONTHLY on "The Blows That Made Me Champion," told of a noted strong man who asked for a chance to box with him. Though this man knew nothing of boxing, he believed his great bulging muscles would protect him from Tunney's best blows. Tunney's first light tap to the stomach knocked the wind out of the fine muscular specimen, and left him helpless.

Another secret of great fighters' endurance, Doctor Fraleck told me, lies in the mechanical per- (Continued on page 135)

The *America* and her crew. From left to right: Bert Acosta, Commander Byrd, George Noville, and Bernt Balchen.

DICK BYRD—Adventurer

The Absorbing Story of the America's *Flight across the Atlantic—A Valiant Escape from Death in Blinding Fog*

By FITZHUGH GREEN

ON JUNE 20, 1926, the SS. *Chantier* steamed briskly on her way westward across the Atlantic toward New York. To the eye of a white gull that circled her mainmast she was just another ship. Yet the *Chantier* at that moment differed enormously from any ship ever afloat on any ocean. *She was the bull's-eye of the greatest radio barrage that had ever been aimed at a vessel at sea.*

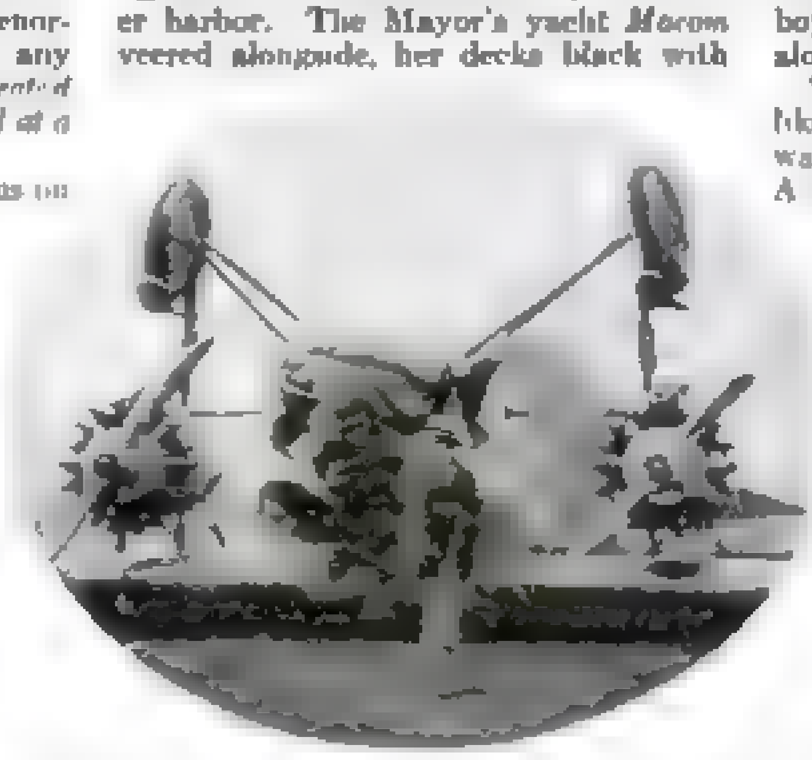
"It's a wonder they didn't set us on fire!" exclaimed the exhausted radio operator when he reached New York.

The cause of the barrage was that aboard the ship was Commander Richard E. Byrd on his way back from the North Pole, via Spitzbergen, the first member of the great "Bull Market of the Air" which has shaken the world in the last two years.

Radios of congratulation, radios of invitation, radios of advice, sympathy, inquiry, adjuration, warning, love, and even envy showered upon the *Chantier*.

"Tell 'em to go to hell," growled Captain Brennan, two-fisted Irish captain of the *Chantier*. But Dick Byrd, Virginia gentleman, stayed up two whole nights trying graciously to meet the mounting torrent of communications.

ON THE morning of June 22nd the *Chantier* anchored in New York's lower harbor. The Mayor's yacht *Macom* veered alongside, her decks black with the high silk hats of delegations from the city and Congress.



The *America* after she crashed and went over on her nose with Anthony Fokker, Byrd, Floyd Bennett, and George Noville in test flight. All were hurt, Bennett severely, and Paris flight was delayed.

Wedged among the silk hats was a little lady in black—Evelyn Bolling Byrd, mother of the hero. Her lips trembled when she caught the searching eye of her boy, but shaped into a smile which he alone could understand.

"For half an hour I was tossed about like a leaf in a storm," Byrd wrote afterwards in describing that eventful morning. A fleet of 200 harbor craft fell in behind the *Macom* as she headed toward the Battery. Squadrons of airplanes roared overhead. Fireboats erupted white streams shot with rainbows. The waterfront was one writhing mass of humanity when the *Macom* docked. Every window of the skyscrapers was filled with faces. Flags everywhere. And the air quivering to shrieking whistles.

Then the parade up Broadway in the famous "Broadway Blizzard" — billions of paper bits tossed from high windows — cheers, flowers, music.

Speeches in the City Hall; speeches at a festive luncheon, plunges through New York traffic, gaping, cheering, and finally in

a railroad private car to Washington, D.C., for the culmination of that day of days.

In the presence of 6,000 distinguished guests, diplomats and legislators, the President handed the Hubbard Medal of the National Geographic Society to Dick Byrd.

Said President Coolidge: "Richard Evelyn Byrd, your record as an officer and a man is illustrious. *You have brought things to pass* . . ."

Yes, Dick Byrd had "brought things to pass" all right. For after a few swirling days of noisy victory the "national hero" had a chance to extricate himself a bit and look facts in the face.

AND some of the facts were not a little disturbing. For instance, he was about [illegible] in debt. He was a naval officer temporarily on a five-days [illegible] tape that had to be [illegible]. He was besieged by publishers, [illegible] theatrical magnates, [illegible] motion picture managers, friends, and hero worshippers. One who has not been through an experience such as this cannot know how difficult and wearing is the lot of a popular hero.

At last Byrd decided to lecture. There were two reasons: it would help his finances and it was the only effective, very dignified way in which he could bring his story to his fellow Americans.

The best way to describe Dick Byrd's lecture tour is to take one day and multiply it by one hundred.

The restless day begins with hurried breakfast in the diner, after a dirty night in a hot sleeping car. Welcoming committee at the train. Introductions, crowds, hospitality; confusion. Drive around town; cheers; confetti; traffic jams. Speeches; ceremonial lunch, more speeches; concert. Reception. Formal dinner. Lecture. Reception. Late supper.

At one-thirty A.M. Dick Byrd drags himself to his hotel or his stuffy sleeping car, to find a pile of telegrams that must be answered at once.

Dick groans, "Wish I were back at the North Pole."

During a break in the tour Byrd kept an appointment in New York that was to have a great bearing on his future life. It was with the late Rodman Wanamaker, one of America's richest men.

"I have been trying for twelve years to cross the Atlantic by air," Dick Byrd told him.

Mr. Wanamaker, tall and lean, smiled. "We should have got together before, Commander. I've been trying to *help* someone cross for longer than that."

"I'm at your service, sir."

"When will you go?"

"As near May first as possible, to avoid fog."

"And a plane?"

"Fokker can build one by April."

Then and there the deal was closed. The rich man would pay the bills, Dick Byrd would lead the flight.

A few weeks later I went with Byrd to the Fokker aircraft plant at Hasbrouck Heights, New Jersey. Fokker, a sturdy pink-cheeked Dutchman with sharp eyes that revealed the uncanny intellect beneath, had the plane in its skeleton stage. Workmen glanced up curiously at the trim young naval officer.

"We have made her stronger and lighter than any plane I've yet built," said Fokker.

"Good. She'll need it," from Byrd. "We may have to cover more than [illegible] miles."

I broke in with, "Suppose he falls into the water, Mr. Fokker?"

"She'll sink in thirty minutes."

Dick never batted an eye.

"SUPPOSE he is forced down on land in the darkness?" I went on.

"Probably kill the whole gang," came the blunt reply.

Dick Byrd glanced up. We thought he was going to say something about the use of flares, or parachutes.

"When will she be finished?" was all he said.

The reply indicated late April. On the way back to New York Dick asked, "Would you be willing to go over and see things are square on the other side?"

"Certainly," said I, and I sailed April second.

On April 20, 1927, Byrd's plane was ready for her factory test. Many others now were planning a New York to Paris flight, but Byrd was weeks ahead. Mr. Wanamaker said, "Don't go on the test flight, Commander. Wait until your machine has proved herself worthy."

But Byrd and Floyd Bennett and George Noville knew that if "Tony" Fokker was going to take the plane up there could be no possible danger.

The big triple-motored machine took the air beautifully in the secret test. After a few circles and dips to prove maneuverability, Fokker brought her almost to a landing. Then, to the surprise of his companions,

Commander Byrd, back from Paris flight, leads a procession to the Eternal Light Monument in New York City, where he lays a wreath. Above: Homecoming flyers return greetings of the throng. Left to right: Noville, Byrd, Clarence Chamberlin, the pilot of the *Columbia*, Balchen, and Acosta

The gallant commander of the *America* signing the golden register of the City of Paris in the Hotel de Ville after he and his crew battled their way from the United States to France in spite of almost insuperable obstacles. When they reached shore from their plane, wrecked on the coast, they were at first mistaken for vagrants.

The wreck of the *America* on the French coast, whence Byrd and companions swam to shore. They had returned to this point after flying over Paris and deciding a night landing would be too hazardous.

he took her up in the air again.

Dick told me afterwards: "Bennett, sitting up front by Fokker, gave me a signal and I knew what was up. The plane, with only a small fraction of her fuel load aboard, was nose heavy. Fokker could not land her without nosing over."

On the next time down the wheels touched the ground. The huge plane was going a mile a minute. Fokker made frantic attempts to jump. Bennett, caught between steering wheel and seat, could not get clear. The plane nosed up and over.

There was a terrific crash. Fokker was thrown clear. Byrd and Noville were slammed about in the fuselage and stunned. Bennett was crushed between the heavy engine and his metal seat.

"Look out for fire!" cried a strained voice.

It was Bennett, hanging upside down with splintered leg and fractured skull, but thinking first of his companions.

Byrd, with a fractured arm, managed to break through the wall of the body. Noville tumbled out with him, writhing from internal injuries. In the minds of all three was the fate of Fonck's men who had been burned to death in a similar accident a short while before.

THERE was no fire. Bennett had had the presence of mind to pull his switch. But it looked as if the brave fellow were out for good.

"I'm done for, Commander," he whispered to Byrd. "I can't see. And I have no feeling in my left arm." Oil streamed over his face from the broken line above him. He thought it was blood.

What a tough break it was! Dick ready a month before the others, ready in heart and mind for years. And now out of the race. For Lindbergh and Chamberlin were on hand—excellent pilots with good planes.

"Please consider my field at your disposal," was the message Dick Byrd sent to both of the flyers. Later he gave

The $100,000 Fokker plane bought by Byrd for his coming South Pole flight but later sold for use by Amelia Earhart on her trans-Atlantic flight.

to Lindbergh charts and weather data.

Lindbergh came over to thank Byrd. I heard the tall, then unknown from the West say simply: "It'll help a lot." His tone carried: "And I'm terribly sorry you've had such bad luck. But this game is like that."

On the afternoon of May 21, 1927, Byrd's plane was christened the *America* on Roosevelt Field, where the big ship had been brought after repairs. She stood before her hangar bedecked with flags. A brass band was playing and thousands pressed about the speaker's stand, but the speaker had not appeared. I decided to have a look for him.

I found four very quiet men in the back room of the hangar. There were Governor Harry Byrd of Virginia; Tom Byrd, Dick's other brother, and Grover Whalen, Mr. Wanamaker's representative. By the window stood Dick in deep thought.

"Lindbergh has reached Paris," I was told.

After all the years of effort and planning to conquer the Atlantic by air, Byrd had lost the race. But Dick is the true sportsman. If he felt bitter disappointment, his face showed no sign of it as he turned from the window and said quietly:

"I am glad the kid got there all right."

A few minutes later he was on the platform. "It is great news we have just heard about Lindbergh," he began, "and my only thought now is about him and his wonderful victory." And so on through one of the greatest eulogies one man has ever paid another.

NEXT day began one of those curious reversals of public sentiment—a flood of telegrams and letters abusing Byrd for having let Lindbergh get there first!

Now came another problem. In view of Lindbergh's success, should Byrd go ahead with his flight? Dick and I met one evening at the home of Colonel Theodore Roosevelt, another close friend, to discuss the situation.

"My flight is a scientific air voyage," said Dick, "which will throw light on the possibilities of a crossing by multi-engine plane, using radio and navigating as one would a ship. I wish I could go quietly ahead and hop off when I feel like it."

"Well, why don't you?" asked Colonel Roosevelt.

"Because I feel that anything I do will detract from Lindbergh's glory."

"I don't believe it."

"On the other hand, many are trying to keep me from going at all. They say there is nothing left to do. But suppose mariners had let Columbus' successful voyage stand, without following it up?"

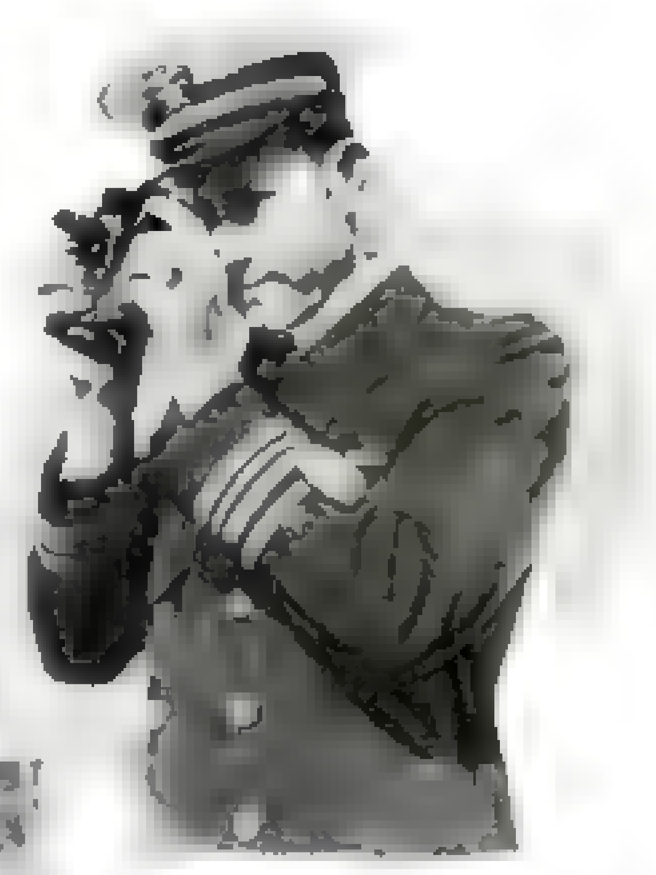
For more than a month Byrd was literally ground- (Continued on page 1[illegible])

The ill-fated trans-Atlantic plane *America* on the beach at Ver-sur-Mer, France, salvaged and partly repaired preparatory to shipment back to the United States. The plane was never flown again.

Teaching "Lindy" Navigation

Why the World's Greatest Pilot Is Learning from a Tutor the A B C's of the Science of Finding His Way

By BOYDEN SPARKES

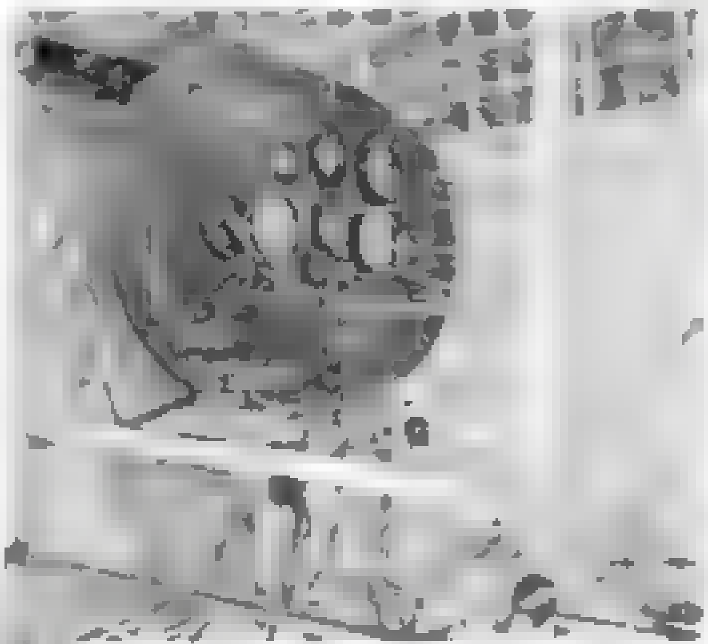


Lindbergh's tutor in the science of navigation, Lieutenant Commander Philip V. W. Weems, U.S.N., demonstrates the simplest method of taking bearings, using a sextant and the wrist watch seen on his left arm.

LINDBERGH, it was announced recently, has an instructor who is teaching him navigation. To most people this seemed as silly as if President Coolidge had engaged someone to teach him political economy; or as if Pershing had begun to study under a drill sergeant.

Americans had thought of Lindbergh as the world's greatest aerial navigator. So he is if by navigator you mean one skilled in finding his way; but mariners have a more precise understanding of the word. As a matter of fact, Lindbergh himself has explained that he knew nothing of celestial navigation when he flew from New York to Paris. Commander Byrd is a navigator. Lindbergh is a pilot skilled in following a course by dead reckoning. Any cadet at Annapolis knew more than Lindbergh about navigation, until the Colonel began his studies.

To understand this suppose you and Lindbergh and Byrd were motoring across the great American desert at night and lost your way at about the time your car broke down. Lindbergh, given all the instruments necessary for position finding, would be helpless to tell you where you were, but Byrd, given those same instruments, could tell precisely your position by sun or stars, and



With these instruments Colonel Lindbergh piloted the *Spirit of St. Louis* across the ocean and on his famous tours of the United States and Latin America by dead reckoning. With them he never lost his way, but, as this article shows, knowledge of navigation and the use of navigational instruments are necessary for greater accuracy in aviation.

The simplest way to determine a ship's position. This need not necessarily be done at noon. At any hour day or night the position may be calculated from observation of sun or a star

then, on a map, plot a course to the nearest service station. By the time this is published, though, Lindbergh probably will have learned enough of navigation to locate his position exactly anywhere.

Lindbergh's teacher is Lieutenant Commander Philip V. W. Weems, until recently commander of the naval supply ship *Cuyama*, an officer quite as modest in demeanor as Lindbergh. When "Lindy" flies nowadays, Weems flies with him, and as they dart through the air America's most famous young man gets his lessons—lessons that have been so simplified that any bright grade school boy probably could master them.

During a recent visit of Lindbergh to San Diego, Commander Weems told the trans-Atlantic flyer that he had perfected what he believes is a "foolproof" set of navigation instruments for flyers. By ordinary methods it requires from fifteen minutes to half an hour to plot a position, that is, to find, by means of navigational instruments, where you are. Weems' simplified method reduces this time to forty seconds on a starlit night, or two minutes by day.

An air mail flyer is a pilot, not a navigator. A pilot is essentially a person familiar with a given course and able to find his way by landmarks. Normally an aviator flying cross-country is provided with a map of the region below him. Favored by good weather, he flies along a corridor about eighty miles wide, the side limits being formed by his ability to see. His map may show a railroad running parallel to his course. Dimly, far to one side, he sees the smoke of a locomotive. There is his railroad! He swings in that direction and follows the tracks. If he has been flying 103 miles an hour for two hours he knows he should be approximately 210 miles from his starting point. The map shows a river crossing his course at right angles 245 miles from his starting point. He begins to watch for that river. Soon he sees ahead a dull bronze ribbon set smoothly in the checkerboard of cultivated fields and patches of woods. There is his river. Assured that he is on his course, he flies on, watching now for a small city the map shows to be about ten minutes farther along. That is piloting.

A MOTORIST making an overland journey from St. Louis to Omaha employs the same kind of skill when he

"turn right at X roads" or "jogs left and then right" at the stone church. The aviator, of course, uses a compass to aid in steering toward his goal. If he becomes lost in a fog he may swoop down close to land and read the legend on a railroad station. A motorist [illegible] the same result by stopping at the first house and asking where he was and how to get to the next town. That sort of thing, on land or sea, is piloting. Generally, though, a pilot knows all the landmarks and guides himself accordingly.

LINDBERGH flew from New York to Paris by dead reckoning, which represents the highest skill in piloting, but still is far short of scientific navigation. Before his start he had plotted his course on a chart. He knew the speed of his airplane. But how did he keep on his course? Fastened in the little window

A [illegible] of the British National [illegible] and Commander J. S. [illegible] [illegible] wanted by the Prince of Wales

Left: [illegible]

instruments to fix his position by the angle of certain of those stars from the horizon. At that altitude he was almost certain that a

above his head was a magnetic compass. But this instrument was of little service to him. If he had been a navigator he might have used it effectively to determine by means of sun or stars where he was; but since he was not, he had provided himself with an earth inductor compass. With this Lindbergh knew at every stage of his journey just how he was heading. A dial was set horizontally near his right hand, with a little crank projecting from its center and with an indicator needle fastened to the rim of its case. A turn of the crank caused the indicator to show on the dial the exact point of the compass toward which his plane was heading. On that splendid instrument he based all his calculations—but he was piloting by dead reckoning. He knew he had been flying so many hours, at such and such a speed, with a wind that was causing him to drift from his course a certain amount in each hour.

WHEN he returned to America, Lindbergh confided to friends that if he ever made another trans-Atlantic flight he would take a navigator with him. Experiences during part of his flight showed him the value of such scientific knowledge. While flying above the clouds at an altitude of 10,000 feet, he could not read from the stars the important information they have given to countless mariners. He lacked the skill and the

tail wind was helping him considerably toward his goal. Yet to remain there would have meant abandoning the one sure means of staying on his course—that of observing the direction of the wind and the drift of his plane. In the course of the night lack of such observations, which were possible only near the surface of the sea, might upset his dead reckoning calculation by several hundreds of miles. So he had to descend. If he had been a celestial navigator then he might have ridden high on the wind, saved gallons of gasoline, and reached Paris earlier than he did, because he could have determined just where he was by observation of heavenly bodies and corrected his course at any time.

The mariner on the bridge of a ship floating on the sea and the aviator in the cockpit of his craft in the air above the sea have the same problem when they seek to determine their position with relation to the earth.

On a certain day of the year a Peary, or a Byrd, standing at the North Pole, might pivot on his heel once in twenty-four hours and keep in view at all times the sun on the horizon. On that same day an observer on the equator would see the sun rise out of the east, and at noon glare down from directly overhead.

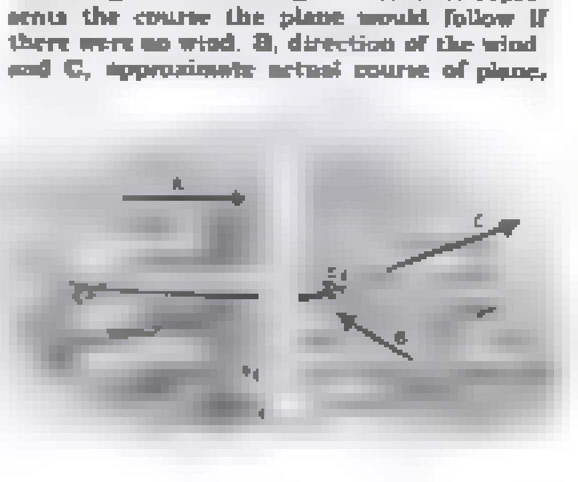
Daily those angles of the sun above the horizon alter as the earth spins on its elliptical orbit about the sun. Remember that the equator is a line of latitude. All the lines marked on your globe as concentric circles, growing smaller toward the poles, are circles of latitude. There are ninety of these arbitrary divisions between the equator and the North Pole, and ninety others between the equator and the South Pole. Each such division is *further divided into sixty parts called minutes.* At noon take your pocketknife and sight along the handle to the horizon. Next lift the blade until it points to the sun. From the same place of observation, at noon the next day, the angle between handle and blade will be slightly different. Tables have been worked out to show what those angles should be at noon of every day in the year and at any place on the earth's surface.

NAVIGATORS read those angles with an instrument called, because its graduated metal arc forms one sixth of a circle, a sextant. With this they measure the angular distance between a heavenly body and the horizon by means of a double reflection from two mirrors. In comparatively recent times these finely made instruments have been improved by the addition of a spirit level, the bubble of which serves the navigator as an artificial horizon.

When a navigator has determined the angle of the sun above the horizon and fixed his position according to latitude, only half his task has been done. He also wants to know the precise degree and minute of longitude. Every schoolboy knows that the meridians of longitude run from pole to pole, cutting across the equator at right angles. The meridian on the globe marked "O" runs north and south through a village on the Thames, below London, called Greenwich. Ten degrees west of Greenwich is another line of longitude. Ten degrees east is another, and so on. These lines of longitude divide the world for the mariner into degrees.

There are 360 of (Continued on page 108)

These diagrams illustrate how wind causes a plane to drift from its course—a factor to be considered constantly in piloting by dead reckoning. In each diagram arrow A represents the course the plane would follow if there were no wind, B, direction of the wind and C, approximate actual course of plane.



Your Dollar Grows Bigger

Why Its Buying Power Is 13 Cents Greater Than It Was in 1920

PERHAPS a dollar doesn't seem much bigger now than during the days of its distressing leanness, but the truth is that it's worth at least thirteen cents more to you than in 1920, the year of peak prices following the war.

The great American dollar is measured, of course, by its purchasing power. Back in 1914 it went a long way. Six years later the same dollar was worth only 48.9 cents. That was its lowest. Since then it has been growing again; until now, according to a recent report of the National Industrial Conference Board, it is worth 62.1 cents, compared with the dollar of 1914.

The reason for this gain in purchasing power has been a decline in the cost of living. The accompanying illustration shows how various necessities have dropped in price from the after-war peak.

Retail food prices, at latest reports, are 31.1 percent lower than in 1920, and more than five percent lower than a year ago. Clothing has tumbled forty percent since 1920, though little in the last two years. Rents have dropped 11.3 percent from their peak in 1924, when they were eighty-six percent higher than before the war, and in the last year they have declined 6.8 percent. Coal last winter was twenty percent lower than in 1920; gas and electricity, twenty-one percent. Other necessities of the average family, were found to be 10.9 percent lower than in 1920, and about two percent lower than two years ago.

The dollars of 1928, 1920, and 1914 according to buying power and the decrease in costs of commodities since 1920.

Still, the total cost of living is more than sixty-one percent higher than before the war. More than balancing this, however, is a general increase in wages. In manufacturing industries, average weekly wages are 118 percent higher than in 1914. In other words, the actual buying power of the weekly pay envelope is thirty-five percent greater than before the war.

Cannibal Mosquitoes

Strange War Planned Between The Ordinary Household Pest And a New Type from France

ONE of the strangest wars ever waged is expected to take place on Long Island this summer. On one side, battalions of humming, voracious, man-biting mosquitoes will battle for their lives. On the other, silent-winged invading insects, imported from faraway Brittany, will move to the attack. Mrs. Charles B. Williams, head of the Mosquito Extermination Committee of the Good Citizenship League of Flushing, N. Y., has written to Dr. J. Legendre, of the Academy of France, for a consignment of his recently-discovered "cannibal mosquitoes," which prey upon their fellows but do not touch human beings.

Dr. Legendre discovered them by accident on a visit to Brittany, and when he returned to the south took along a box full. In the pest-ridden lowlands of the River Gironde, he released them, and in twelve months they exterminated the biting and malaria carrying species.

The picture that your imagination conjures up of these microscopic dragons of the air, battling for supremacy, shows you but one new way in which a long line of attack will move against man's irritating and dangerous enemy.

From the waters of the Spanish Main, a tiny fish, no longer than your thumbnail, is being imported by New Jersey experimenters to act as the "submarine" section of this offensive. These fish, the Gambusia, eat the "wigglers" from which mosquitoes develop, cleaning up a pond in a short time.

This "wiggler," or larva stage, is the one at which most attacks are aimed. From mosquito eggs, laid in stagnant water, the larvae emerge and swim about in search of food, rising frequently to breathe through little periscopelike tubes which they thrust above the surface. The third stage is the pupa, or intermediary one, from which graduate the insects ready for business.

In the past, crude oil and other substances were used to coat the surface of the water and prevent the "wigglers" from breathing. Dr. William Rudolphs, of the New Jersey Agricultural Experiment Station, suggests another method. He points out that a solution of copper sulphate, so weak that it will neither pollute the water nor harm its useful creatures, will destroy the tiny organisms upon which the "wigglers" depend for food and life. In Louisiana, airplanes will scatter poisonous Paris green on the waters.

The recent death of Dr. H. Noguchi, Japanese martyr to science, who discovered the South American yellow fever germ only to fall victim to the disease himself through the bite of a mosquito, calls fresh attention to the menace of these insects. Each day some new plan is suggested for their extermination. They range from training bats to dropping poison gas from airplanes. It is even hoped that the recent discovery made in England by Cambridge students that mosquitoes are attracted by the color blue and repelled by yellow will prove useful.

Government officials estimate that the mosquitoes of the United States run up a bill of over $100,000,000 a year.

Now You Can Build Modernistic Furniture

Simple Plans by HERMAN HJORTH for a Stand and a Bookcase in the Revolutionary New Style Which Reflects the Beauty and Utility of "Skyscraper" Architecture

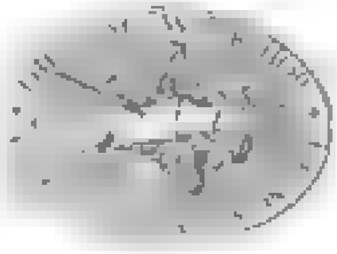
ONLY in the more expensive and exclusive shops can you buy furniture of the new or modernistic style. The pieces are by no means moderately priced, yet the demand for them is so great that they are snatched up by impatient buyers. Department stores vie with each other in exhibiting the latest creations of designers and craftsmen; and everywhere the originality, color, and brilliance of the new movement are making themselves felt.

From the amateur craftsman's point of view, the new furniture has the great advantage of being simple to construct. A few common tools are sufficient to build the pieces, and elementary skill in woodworking is ample for all the technical requirements.

Before considering the actual construction of the modernistic stand and bookcase illustrated on the opposite page, it would be well to stop for a moment to consider the revolutionary spirit of the new furniture. How does it come that we are turning now to the problem of building pieces so radically different from anything ever attempted before, either in the furniture factory or the home workshop?

Styles in furniture construction have changed almost with each succeeding generation. In some instances these changes were the result of religious or political events; in others, archeological discoveries (Herculaneum and Pompeii) or imperial commands (French Empire); and in still others, merely a popular reaction to the prevailing styles and a demand for something to harmonize with the changes in architecture and living conditions in general.

THE more recent styles or periods of furniture design in this country were the American Empire, the age of black walnut and the Mission style. Duncan Phyfe was the chief exponent of the first of these, which was at its height about 100 years ago. The second era, also called the "Dark Ages" on



account of its lack of beauty, lasted until about the end of the nineteenth century. The Mission style, which originated in California, was very popular for a time during the beginning of this century, but somehow it did not last. Almost overnight the reaction to the squareness and massiveness of Mission furniture caused the pendulum of popular taste to swing to the other extreme—the delicate curved forms of earlier periods.

The craze for antiques, which has by no means abated, has practically exhausted the available supply. Reputable furniture makers try to satisfy the popular taste by reproducing the antique designs; others, less scrupulous, represent their product as the genuine article and sometimes do their work so cleverly that even experts are deceived.

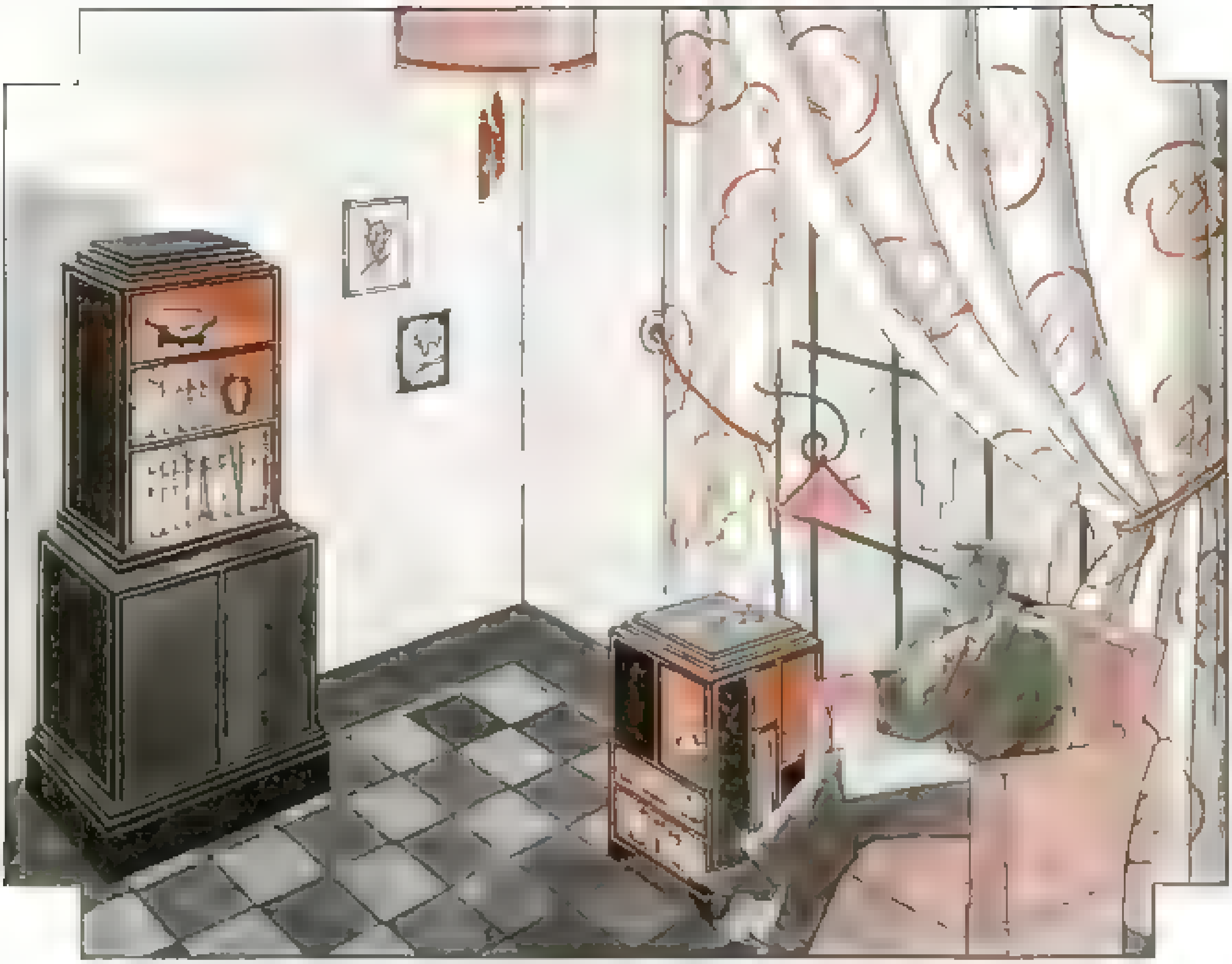
This state of affairs has put furniture designers on their mettle. They believe they can produce a style of furniture that is entirely original, just as beautiful as any of the older periods, and more useful and appropriate to present-day architecture and living conditions. A great impetus to this movement was given at the International Exposition of Modern Decorative and Industrial Art in Paris in 1925, where examples of this new art from many countries were prominently displayed.

IN THIS country modernistic furniture has been exhibited at various museums, department stores, and exclusive shops. The new flagship of the French Line, *Ile de France*, is furnished with this type of furniture. Progressive business men have been among the first to see the utility and beauty of the new styles, and in New York and Chicago some of the finest offices are decorated in modernistic fashion—floors, walls, draperies, furniture, pictures, and accessories.

While there is a common bond between the modernistic designs, each country seems to be developing certain characteristics and peculiarities. In this country it is the "skyscraper" type of furniture, inspired by the impressive and original type of architecture familiar to the residents of every large American city.

Theodore Frankl, who is one of the most successful designers of this new furniture, asserts that it "reflects the dominant architectural mode in its forms and

Like so many modern pieces, this bookcase can be nailed together. The drawings reveal the extraordinary ease with which the new furniture can be constructed—a great advantage from the home workshop standpoint.



Stand and bookcase in modernistic manner. They are striking occasional pieces for almost any style of living room, provided a suitable color scheme is chosen.

decorations, just as furniture of all ages has been led by architecture." However, it is not a matter of form alone, but also of utility. Tall pieces of furniture naturally are more useful than lower ones occupying the same floor space, just as a building of twenty stories is nearly twice as useful as one of ten stories having the same ground plan.

In the new mode, tall pieces of furniture are balanced by the lowness of mobile pieces such as chairs, tables, and stands. Many of the pieces have a variety of compartments for books, smoking or card-playing accessories, magazines, and other small objects, utilitarian or decorative. A piece of each type, not too extreme in design, is shown in the accompanying illustrations.

For the construction of these projects, it is suggested that a soft and inexpensive wood like white pine, whitewood, chestnut or cypress be used. If the boards are not bought cut and squared to the exact dimensions, clamp together the ones that are to be of the same dimensions and plane them to length and width while so clamped. In the stand, for example (see the working drawings on page 92), the edges of the four main shelves, which are ¾ by 6 by 14¾ in., should be planed together. This is true also of the two large sidepieces, which are ¾ by 8½ by 20¼ in., the two small sidepieces, which are ¾ by 8¾ by 10¾ in., and the other parts that are to be made in pairs.

Nail a section of the stand together as shown in the isometric view and then make another section to pair with it. Place one of them opposite to the other (see section *BB*) and 3 in. apart, and nail on the top and bottom pieces, which are ¾ by 16 by 16 in.

These pieces, which in the meantime should have been glued up of narrower boards, may be left a little wider and longer than their actual dimensions and then be planed flush with the sides, front, and rear after they have been nailed in place.

The piece which forms a narrow shelf between the two sections (it is ¾ by 3 by 16 in.) should have the grain running the short way; otherwise it is likely to shrink and make a bad joint. If 3¼ in. is added to the length of the pieces glued up for the top, the extra length may be sawed off one end after the glue is dry and this narrow shelf made from it.

Fit and nail the remaining pieces in place. Saw the four feet from a solid piece or make them by gluing together three pieces 2½, 2 and 1½ in. square respectively. Set all nails below the surface with a nail set.

The bookcase (see the drawings on page 56) should be made in two sections. The two sides of the lower section—they are ¾ by 15 by 34¾ in.—and the bottom and two (Continued on page 92)

"SKYSCRAPER" furniture they call it sometimes. Modern or modernistic furniture is a better name, but by any name it represents the new mode in furniture—the furniture that we shall soon see in many homes.

¶Revolutionary? Mechanistic? Yes, but useful, beautiful in the structural harmony of its proportions, and strikingly original and decorative. The new designs promise to do for furniture what the set-back skyscrapers have done for architecture.

¶Above all, modernistic furniture is simple in construction. Every home worker, if he has good designs to follow, can build decorative modern pieces quickly, easily, and inexpensively.

¶In the accompanying article POPULAR SCIENCE MONTHLY presents two of a series of modernistic pieces designed for construction in your home workshop. If you wish to build one or both of these, you will be greatly aided by our Blueprint No. 88 (see page 102). The blueprint contains scale drawings, an itemized list of tools and materials, and an outline of the method of construction.

How to Make a *Bremen* Model

By J. DANNER BUNCH and AVISON F. KOCH

J. Danner Bunch holding the model of the *Bremen*, which weighs complete only 2 oz.

BY BUILDING a flying model of the *Bremen*, the Junkers monoplane which will always hold a shining place in the history of the conquest of the air because of its east-to-west flight across the Atlantic Ocean, you can accomplish two things.

First, you can make an exceedingly attractive model of a type that heretofore has not been seen at any of the model airplane tournaments.

Second, you can construct a model that, unlike most scale models, will fly an astonishing distance.

The writers' model of the *Bremen*, which was designed and built especially for readers of POPULAR SCIENCE MONTHLY, flies from 700 to 800 ft. consistently and on several occasions has reached the 1,000-ft. mark. The longer flights are made when the model is hand-launched, but it also takes off under its own power after a run of three or four feet, and flies with exceptional speed and stability.

Some of those who have built the simpler models in the POPULAR SCIENCE MONTHLY series have asked for an advanced scale model. The *Bremen* model can be so classified. Any careful model maker can construct it, but he will have to use painstaking workmanship throughout.

TO MAKE the task somewhat easier, two blueprints have been prepared which show all the essential details full size and contain a large amount of information that it is impossible to give in illustrations as small as those in the magazine. Unless you have built other scale models and are thoroughly familiar with their construction, it will pay you to obtain the blueprints, for they will save you a great deal of work in laying out the model. The blueprints are Nos. 89 and 90 in the list you will find on page 102.

To fight the terrific head winds encountered on an east-west Atlantic flight requires an airplane of the utmost efficiency. In the Junkers sturdy airplane *Bremen* the German-Irish flyers found such a ship. It is a low-wing cantilever monoplane. Built entirely of duralumin tubes, channels, and corrugated sheeting, the plane, with its unusual low-wing design, seems to suggest instability to the layman, but in reality it is one of the happiest designs considered from an aerodynamic and engineering standpoint. The high center of gravity and the dihedral angle make the ship exceptionally stable. Structurally, the ship is stronger than the more normal type because the strains of the main weights, the drift strains and the landing forces are taken by strong structures built into the center section of the wing. This strong central structure is possible only in the low-wing types; on other types certain bracing must be omitted within the fuselage to make room for the pilots, tanks, and equipment.

THE fuselage of the model is made of split bamboo and the struts are joined to the longerons with a drop of cement, preferably of the ambroid type. You need, of course, a full size drawing of the side view. This is contained in the blueprints, but it also can be made by enlarging to full size the drawing of the side view which accompanies this article.

Note that the side view is made around the thrust line or axis of the propeller. Across the thrust line are perpendicular lines at the strut locations, which are known as stations. Station No. 1 is the fuselage nose strut, No. 2 is the next strut, which is 1 15/16 in. back. The remaining distances are as follows: No. 2 to No. 3, 1¾ in., No. 3 to No. 4, 1⅝ in.; No. 4 to No. 5, 2¼ in.; No. 5 to No. 6, 1¾ in.; No. 6 to No. 7, 1¾ in., No. 7 to No. 8, 2 1/16 in., No. 8 to No. 9, 2⅛ in.; No. 9 to No. 10, 1⅝ in., and No. 10 to No. 11, 1⅛ in. Station No. 11 is the tail post.

To get the shape of the upper longeron, proceed as follows: The longeron at station No. 1 is ⅝ in. above the thrust line; at No. 2, 15/16 in., at No. 3, 1 1/16 in., at No. 4, 1 3/16 in.; at No. 5, 1 1/16 in., at No. 6, 1 1/16 in., at No. 7, 1⅛ in.; at No. 8, 15/16 in.; at No. 9, ⅝ in.; at No. 10, 5/16 in.; and at No. 11, 3/16 in. For the lower longeron, measure down the stations from the top longeron, as follows: At No. 1, 1¾ in.; No. 2, 1¾ in., No. 3, 2 5/16 in.; No. 4, 3¼ in.; No. 5, 3 3/16 in.; No. 6, 3⅜ in. No. 7, 3⅛ in.; No. 8, 2⅝ in., No. 9, 1¾ in., No. 10, 1 5/16 in.; and No. 11, 1¼ in.

SPLIT the bamboo to the proper size with a knife. The front longerons are a scant ⅛ in. square, the rear longerons, (back of the splice) a scant 3/32 in. square. The bamboo should be split so as to preserve the hard, glossy outside surface. Let this glossy surface be the upper side of the upper longerons and the lower side of the lower longerons. Join the rear longerons to the front longerons with a bevel splice about ¾ in. long. The splice is made with cement and a few wraps of silk thread. Bend the longerons carefully over a candle flame. For the extreme bends, dampen the bamboo. As you bend the longerons, match them carefully to the blueprint or your own drawing. When the longerons are bent, mark the strut locations accurately. Then cut the struts, getting the exact strut lengths from the blueprint.

This is an advanced scale model of exceptional speed and stability in the air. Full size working drawings are combined in POPULAR SCIENCE MONTHLY Blueprints Nos. 89 and 90. See the list on page 102.

Step-by-Step Instructions for Building a Remarkable Low-Wing Monoplane That Flies 700 Feet at High Speed

The struts are split bamboo with the hard gloss on the outside of the fuselage.

In cross section the struts are as follows, all the measurements being scant: No. 1, 1/8 in. sq.; No. 2, 1/8 in. sq.; No. 3, 1/16 in. sq.; No. 4, 3/64 by 1/16 in.; No. 5, 3/64 by 1/16 in.; No. 6, 1/16 by 1/8 in.; Nos. 7, 8, 9, 10, and 11, 1/16 in. sq.

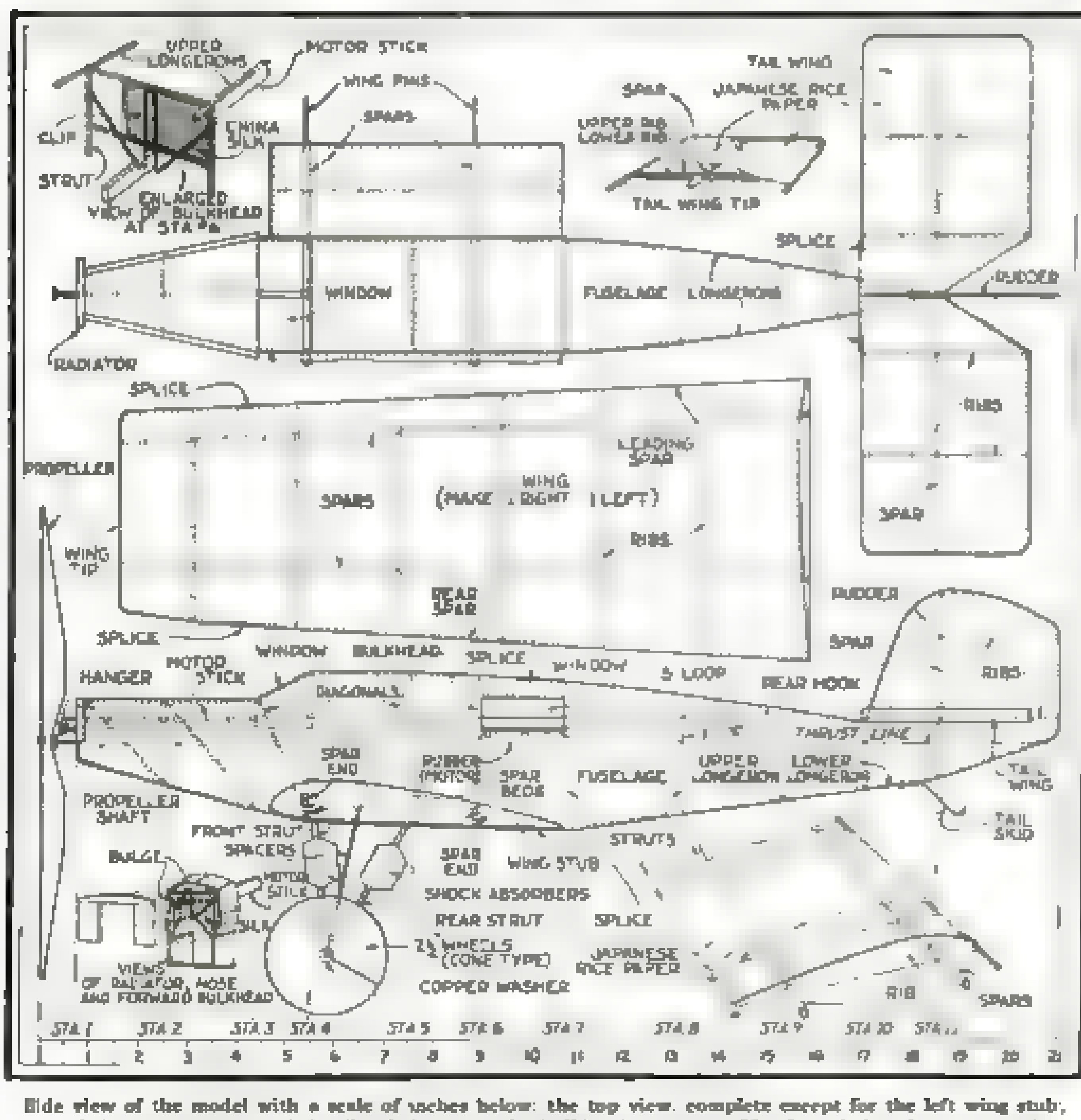
To assemble the sides, lay the upper and lower longerons along the length of a sheet of ruled paper; the lines are useful for checking the strut locations and keeping them accurately one above the other. Cement the nose and tail struts in place. Then proceed with the other side. Let the cement (if of the ambroid variety) dry until it is clear amber brown in color (at least an hour). Then cement the remaining struts in place, leaving out the strut at station No. 3 for the present. Let these sides dry thoroughly before disturbing them.

A view to show the undercarriage and underside of the wings. Note the "toothpick" propeller. No photograph can convey the transparent delicacy and grace of this remarkable model of the Bremen.

The next step is to install the horizontal struts. At station No. 5 the fuselage is 2 3/8 in. wide, but it is only 5/8 in. wide at the nose, so a slight bend must be made in the longerons at station No. 3. Cut struts for horizontal upper and lower stations Nos. 3, 4, 5, and 6. These are bamboo a scant 1/16 by 2 3/8 in. long. Cement the two fuselage sides together with struts at stations Nos. 4 and 6 in place. Lay one side of the fuselage on a flat table and balance the other side in place on the struts, checking it by sighting and with draftsman's triangles. Hold it in place a few minutes until the cement begins to set. Let it dry thoroughly and then install struts at stations Nos. 3 and 5, also vertical struts No. 3 and horizontal struts No. 7, the latter being a scant 1/16 in. sq.

When the assembly has dried, bind the vertical tail posts together with a few wraps of silk thread and install horizontal struts at stations Nos. 8, 9 and 10. These are bamboo, a scant 1/16 in. sq. and the lengths are cut to fit. Install the horizontal struts at stations Nos. 1 and 2. Cement a strut between lower No. 10 and the end of the fuselage in the lower horizontal bay. The strut which forms the tail skid support is bamboo, a scant 1/16 in. sq. It runs fore and aft.

When the fuselage is thoroughly dry, the motor stick clips can be installed. First make the bulkheads. The front one goes on at station No. 1. Place a bamboo strut 1/16 in. sq. crosswise horizontally 1/2 in. above the thrust line. Cover the front with China silk, cementing the silk in place firmly. Shrink the silk with three coats of banana oil. Make a U-shaped clip of No. 8 piano wire. It should be 1/4 in. wide and long enough to reach the depth of the bulkhead plus the depth of the motor stick. Below the motor stick make a slight inset bend in the clip to keep the stick from dropping out; then bring the ends upward across the bulkhead again and out at the sides of the fuselage. Fasten the clip firmly in place, using cement freely. Then cut away the silk that is in the way of the propeller shaft and motor stick.



Side view of the model with a scale of inches below; the top view, complete except for the left wing stub; one of the main wings; and details of the nose, the bulkhead at station No. 6, and the wing construction.

THE second bulkhead is at station No. 6. Install a horizontal cross strut of 1/16 in. sq. bamboo 1/2 in. above the thrust line. Cover from this strut upward with China silk as you did at station No. 1. Make a clip as before, only this one is longer as the bulkhead is larger.

Now install the window sills. They are bamboo, a scant 1/16 in. sq., and go between stations No. 6 and No. 7. The sills run parallel to the thrust line, the lower one 1/4 in. above the thrust line, the upper one 1 in. above the line. These form the windows through which you will later reach your fingers to press the motor stick into and out of the rear clip.

The undercarriage is the Junkers split-axle (Continued on page 96)

Onward Strides of Science

Insect Thugs Fingerprinted

THE world of insects, plants, and lower animals is full of cutthroats, murderers, robbers, and grafters, and man has taken it upon himself to do the punishing.

Assuming the rôle of police officers, Dr. C. W. Stiles, of the U. S. Public Health Service, and Albert Hassall, of the U. S. Bureau of Animal Industry, have just completed a "rogues' gallery" of 400 notoriously bad insects with their records and "fingerprints." Largest in number are the insect sneak thieves and prowlers—170 kinds—which live as parasites on the human body. Next come the vicious ones, like the stinging ants and biting flies. Eighty-five varieties stand convicted of assault and battery; nearly 100 others of spreading disease; and seventy of causing skin diseases. Twenty-seven have been found with poisonous weapons in their possession, and thirty-one have been caught in the act of damaging human food and drink. Many others, like malaria mosquitoes, are held under suspicion of spreading disease.

More than one insect, however, has been deputized by mankind to scourge the offenders. Latest of these is a big plundering locust which, according to reports from Greece, is now employed there to wage war on the ordinary locust pests that cause heavy damage to crops.

Professor E. A. Andrews, of Johns Hopkins University, recently observed in North Carolina a steal as bold as any human crook could contrive, perpetrated first by tree frogs and then by spiders, against a number of pitcher plants, whose leaves trap insects for the plants' food. Inside the trumpet-shaped leaves sat the thieving frogs, devouring every insect which tumbled in. Then the spiders spun webs across the openings, and robbed both frogs and plants.

Your Body a Radio Station

ALMOST everyone has had the strange experience of "feeling the presence" of some person in a room, when that person was out of sight or hearing.

Ancients believed the human body gave off unseen emanations and they were more than half right, according to the latest findings of two physiologists of the Technical College of Munich, Professors Ferdinand Sauerbruch and W. O. Schumann. With sensitive radio instruments they claim to have discovered that our bodies send forth electrical emanations which can be detected six feet away.

The skin holds an electrical charge, they say, as if connected with a hidden battery or dynamo. They have found no evidence, however, that the emanations can be detected by the bodies of other persons near by, or that they have anything to do with so-called personal magnetism or thought transmission. They do believe, however, that the electrical field may have an important relation to health, and with this idea in view are continuing their experiments.

Equally surprising are the recent experiments of Dr. Frederick Tilney, professor of neurology at Columbia University, which indicate a hitherto undiscovered sense in animals—a magnetic sense. It is this, he suggests, which may give the homing pigeon its compass bearings.

Greatest Meteorite in History

IN A lonely forest in the far-off province of Yenisei, Siberia, a herd of 1,500 reindeer browsed among the trees. Suddenly a gigantic cannon ball crashed from the heavens with a colossal explosion. The reindeer herd vanished, wiped from the face of the earth. Millions of great trees were mowed down like blades of grass. In a village fifty miles away two farmers were knocked down by the blast and burned by its heat. Passengers on a railway train 400 miles away felt the heat and the shock.

Such was the fall of the greatest meteorite in history, which occurred June 30, 1908. That it is no fairy story has just been proved by a Russian exploring expedition, headed by N. T. Bobrovnikoff, which went to investigate rumors of the event. Where the meteorite struck, they found a devastated area twenty miles in diameter.

The earth is constantly being bombarded by meteorites. A report in POPULAR SCIENCE MONTHLY last month told of a tiny celestial bullet that seared the neck of a Japanese baby. Most of them cause no damage, but if one should chance to fall on one of our big cities, the disaster would be appalling beyond imagining. And, of course, it might happen.

LATEST discoveries, inventions and theories in the various scientific fields that are of prime importance because of their bearing on the affairs of our everyday life are recorded each month in these pages. Here are presented not only what geniuses of the laboratory and explorers the world over for new knowledge have done for you and us, but what they hope and plan to do next.

New Elements Found in Sun

A NEWLY discovered element and a familiar one in new guise have been identified in the sun—hafnium, a metal only recently discovered on earth, and cobalt, twin metal to nickel, in an electrified state—the U. S. Bureau of Standards announces. Dr. William F. Meggers, Spectroscopic Laboratory Chief of the Bureau, discerned them through examination of faint lines in the sun's spectrum or light band. Although the sun's common elements, such as sodium, metal calcium, iron, and nickel have long been known, more obscure substances are just being identified.

One of the few specimens of hafnium in existence is at the U. S. Bureau of Standards—a small sample sufficient to make identification tests but too tiny to test the metal's possible uses. Cobalt is familiar, but the discovery of ionized or electrified cobalt vapor in the sun came as a surprise.

Trailing Unknown Planet

ASTRONOMERS are scanning the skies these nights for an undiscovered planet believed to exist beyond Neptune, farthest known planet from the sun.

Evidence that there is such an unseen planet was advanced recently by Prof. W. H. Pickering, formerly of the Harvard Observatory, in the form of charts showing that the planets Neptune and Uranus are, at times, pulled out of their usual courses, apparently by some unknown body. The gravitational attraction of an undiscovered planet, he thinks, is responsible.

Photographs of the night skies obtained through powerful telescopes at the Lick, Yerkes, and Harvard observatories, however, have as yet failed to reveal the new world.

Professor Pickering has calculated that the planet is 6,300 miles in diameter, slightly smaller than the earth.

As told in a recent issue of POPULAR SCIENCE MONTHLY, our solar system includes many tiny planets, called asteroids, most of which are never seen by the naked eye. Eros, nearest the earth, is to pay us a flying visit in 1931. It will approach within 16,200,000 miles.

Man-made Sun Grows Wheat

THE feat of Joshua in commanding the sun to stand still was hardly more miraculous than are the present-day laboratory achievements in manufacturing artificial suns and putting them to work.

Some weeks ago two agricultural chemists in the University of California, Professors A. R. Davis and D. R. Hoagland, "planted" wheat seeds in a laboratory where they manufactured sunshine from a dozen 300-candlepower lamps filled with glowing argon gas and created soil by filling jars (Continued on page 114)

Ordinary Print Made Readable for the Blind—Your Body a Radio Plant—Experts Grow Wheat in a Few Weeks

Orchid Bombards Bees

One of Nature's amazing schemes of using honey-seeking bees to carry pollen from one flower to another for the process of fertilization is found in the "Poor Man's Orchid," pictured at the left. In the blossom is a tiny catapult which, responding to the insect's weight, automatically hurls a shower of pollen upon the intruder. The picture shows the mechanism responding to the touch of a pencil.

Mystic Fire Fighter

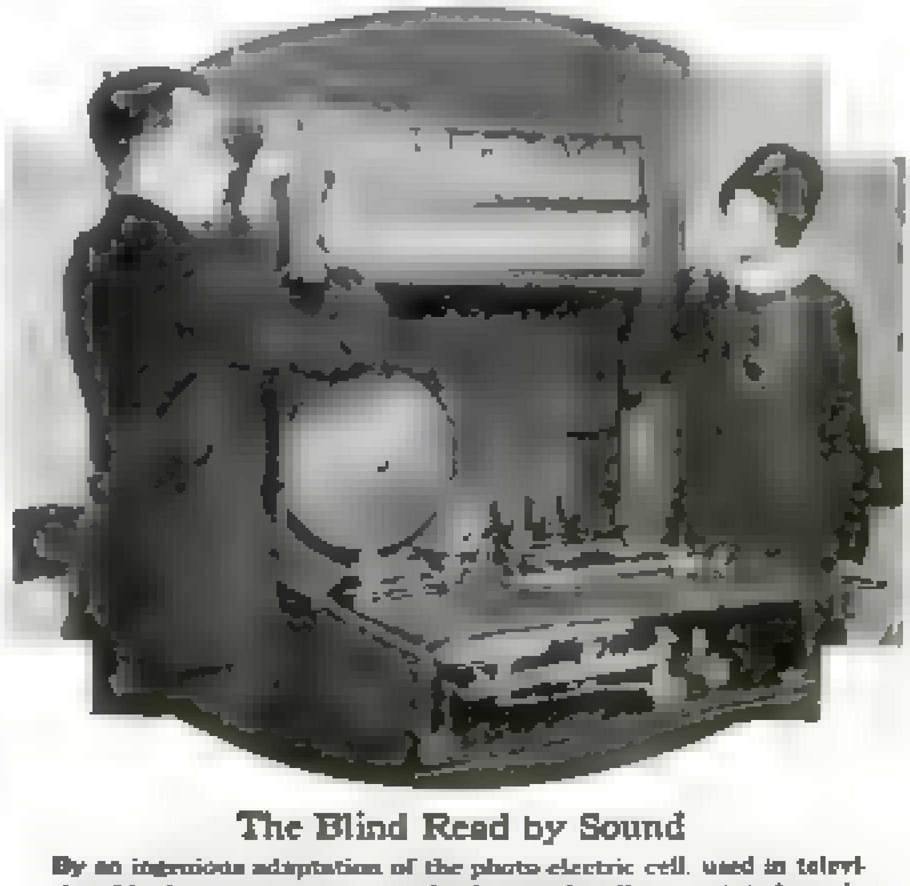
Two Ohio consulting chemists, C. A. Hallwell and C. A. Thompson, were as much mystified as anybody recently when they discovered that solutions containing salts of alkali metals—sodium, potassium, calcium and caesium—can put out a fire three times as quickly as standard soda acid types of extinguishers. At the right they are seen extinguishing a laboratory blaze in twelve seconds. Best previous records have been from thirty-five to forty-five seconds.

A Manufactured Geyser

Copying Nature's methods, Prof. H. J. Spencer of Northwestern University recently made this realistic working model of "Old Faithful" geyser. A long pipe filled with water is surrounded by a jacket. Heat is applied at the lower large end of the pipe. Because of differences in pressure, the boiling point is higher at the bottom. Thus, when a mass of hot water rises to a region of less pressure, it turns suddenly to steam and spurts high into the air carrying water with it, then drops back. The process is repeated once every fifteen minutes.

Motor Fuel from Vegetables

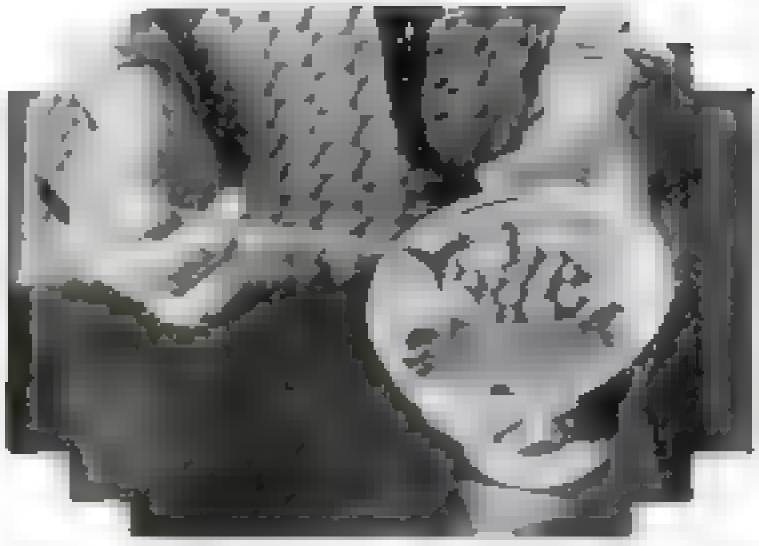
Daniel W. Hoge, Los Angeles chemist, is seen below in his back yard laboratory where he is distilling from vegetable matter a new liquid fuel that he says is superior to ordinary gasoline and that can be produced for a cent and a half a gallon.



The Blind Read by Sound

By an ingenious adaptation of the photo-electric cell, used in television, blind persons now are enabled to read ordinary printed words. In the apparatus, invented by Robert E. Naumburg, of Winchester, Mass., a light-sensitive cell controls the electric current operating a loudspeaker. The blind person scans printed words with a beam of light. When the beam falls upon black letters the loudspeaker is silent; when it falls on the white background, a buzzing is heard. Thus, guided entirely by sound, the reader can follow the letters.

When your floor is covered with dirty water after scrubbing, it takes but a few seconds to clean it with a new floor pan with which is used a rubber squeegee. The rubber strip pushes the suds off the floor and into the pan. Then a rinse with clean water, another once-over with the pan and squeegee, and your floor is clean.

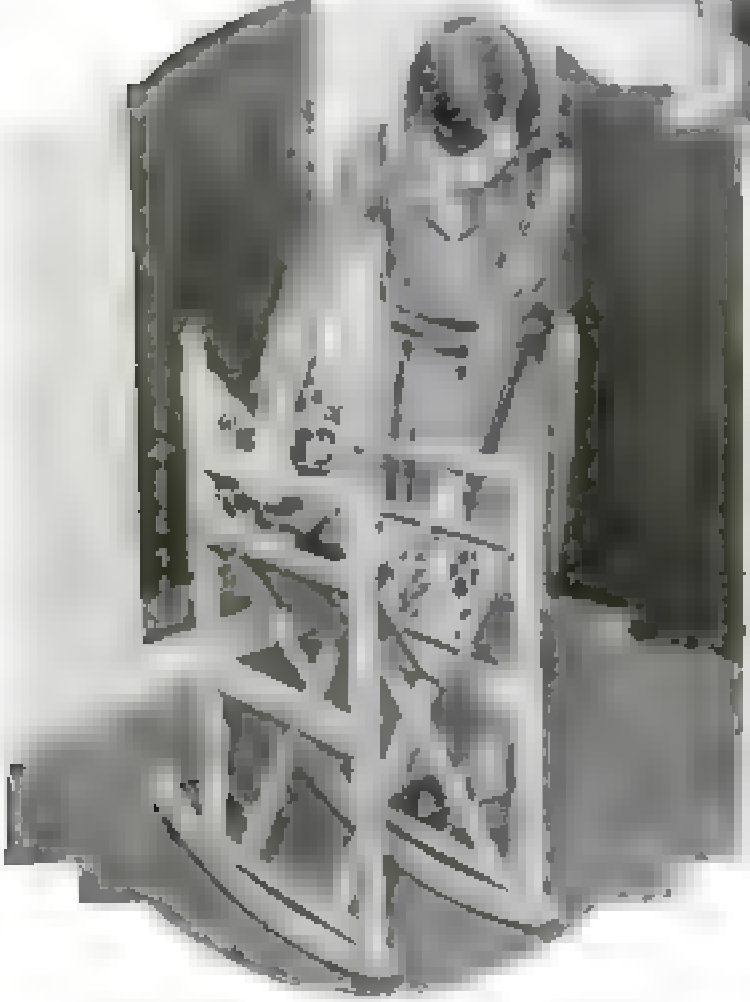


Fork and spoon combined is an ingenious new kitchen tool of many uses. For good measure it has slits that provide a useful colander when a spoonful of fruit is to be drained of its juice.

Practical New Home Utilities

A picturesque but time-wasting custom—the flipping of a pancake while cooking—is banished in a rapid new electric pancake cooker (right) that browns both sides at the same time. The cakes have an even thickness and an expanding hinge allows for their rising.

Even your screen and flower box can stay in place while you wash the outside of your windows in safety with this new device. A long brush with an adjusting bar to clamp firmly in any window, it is placed in the frame just outside the glass and covered with a cloth. Move the window up and down and the brush forces the cloth into every crack.

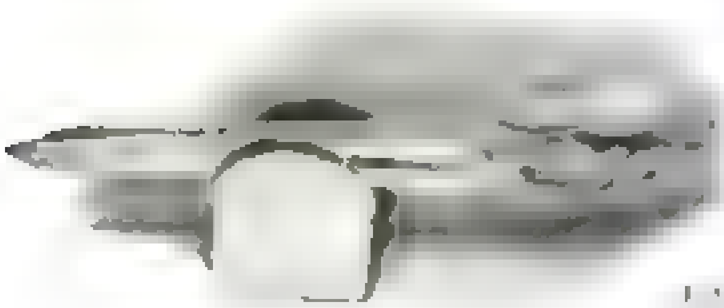


Now the folding rocking-chair! This latest addition to the list of portable furniture is a sturdy, light-weight jointed affair with a fabric seat; it collapses into small space for storage, and is instantly unlimbered for use. The rocking feature adds the last word in comfort.

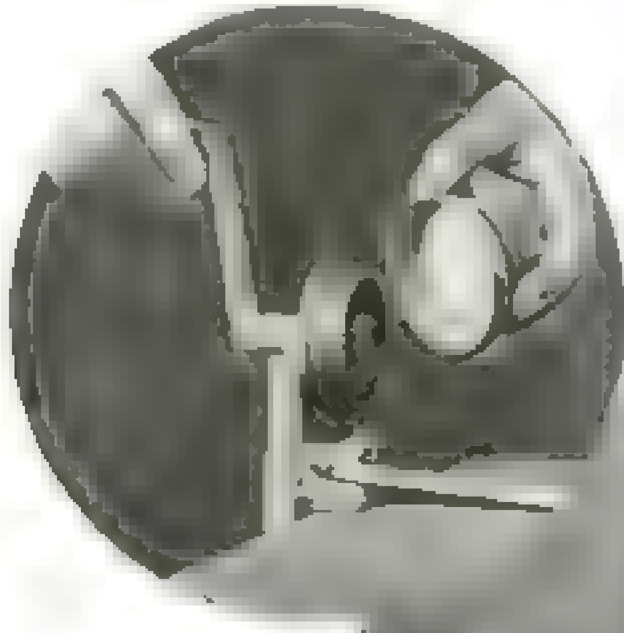
With the new doughnut cooker shown at the left that works like a waffle iron, you can make doughnuts of the greaseless sort, it is said, on top of any range—gas, oil, electric, or coal. A dozen in ten minutes is the capacity of the iron, which cooks three at once.

A new hinged pan, deep enough for all cooking, has one section on one side and two on the other for frying or stewing. With one side folded over it is a good roasting pan.

With an ingenious new cupboard on the inside of your kitchen door parcels can be delivered whether you are at home or not. Three flaps giving access to the cupboard shelves can be opened from the outside through holes in door. When flap is closed it locks automatically.

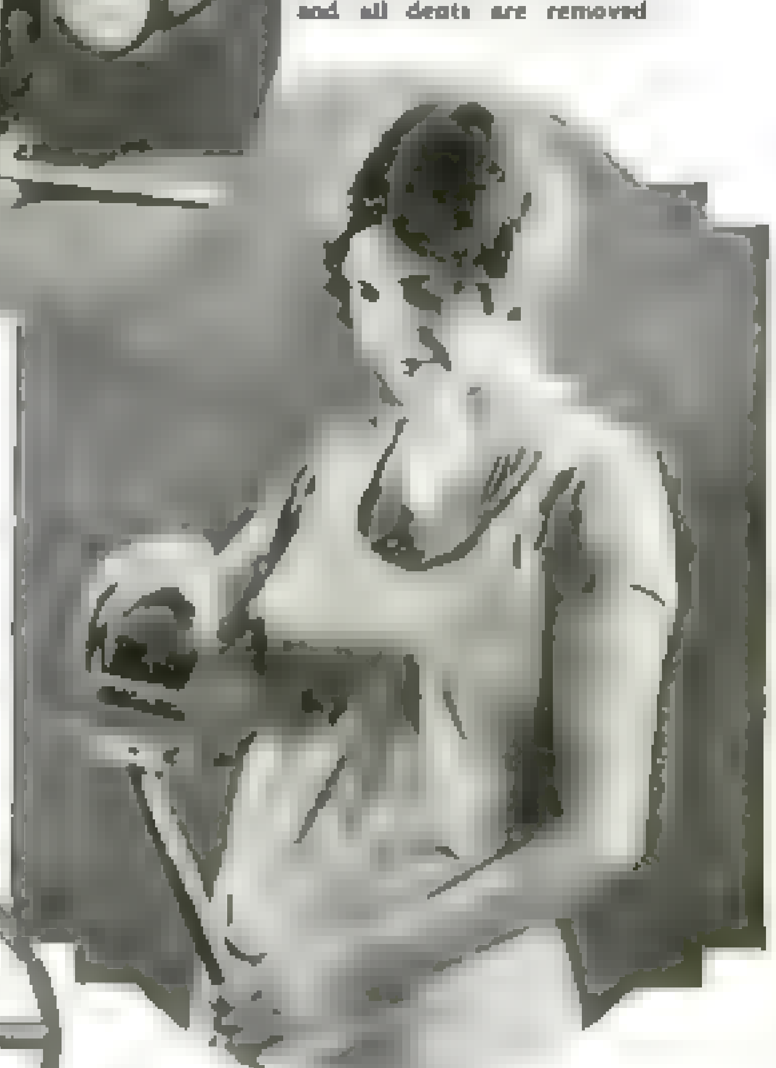


Patterned after the back saw, this new aluminum kitchen knife cuts meat and bread with equal facility. Tiny teeth on the blade give it sawlike powers. A thumbscrew tightens blade for back cutting.

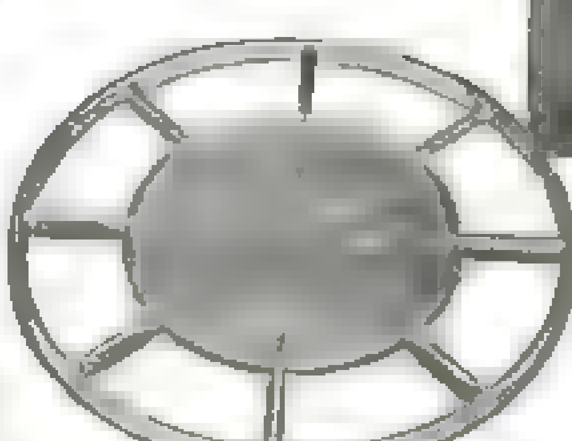


Bent jar caps are straightened, and the edges of new ones improved, as seen at the left, by a handy little machine that clamps to your kitchen table. A few turns of the crank force a threaded die into the cap and all dents are removed.

Folding tables and benches for dining or breakfast nooks are becoming increasingly popular. Here is a new one particularly easy to install. It requires no inclosure, and carries with it its own attractive "camouflage" in the form of a headpiece that gives the closed set the lines of a tall panel or make-believe doorway. The benches swing closed across the front as shown.

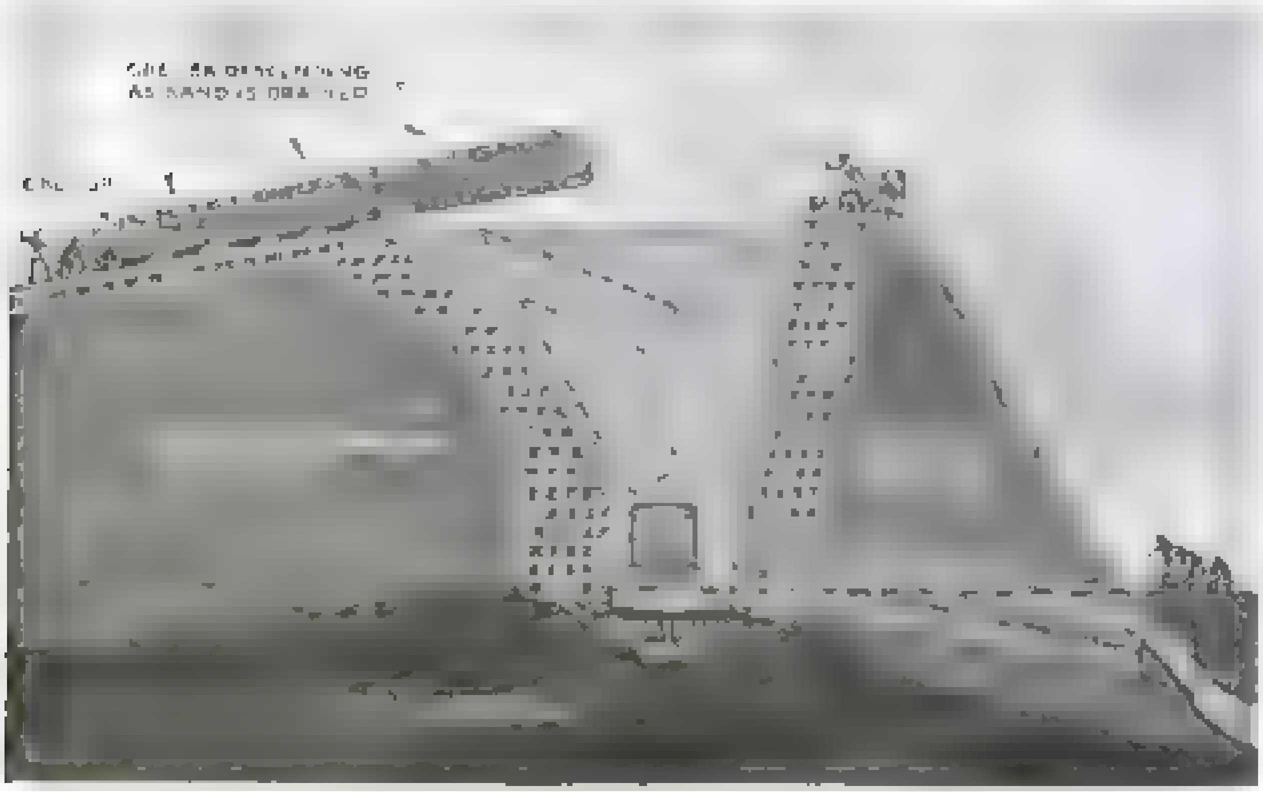


Scrubbing floors without getting down on one's knees is made possible by a long handle that will clamp on any brush, gripping it firmly while the person running it back and forth on the floor is erect. Thus scrubbing becomes as easy as using a vacuum cleaner.



The difficulty of slow cooking on a gas stove is overcome by an inexpensive new plate which, when placed over a burner that is turned low, spreads the flame around the edges so evenly that very little heat reaches any one point.

Triumph of Ancient Egypt's Engineers



This diagrammatic drawing shows the ingenious method whereby ancient Egyptian engineers erected the towering obelisks which they had not the physical nor mechanical power to lift. The system amounted to building a pit around the base set for the monolith and then dragging the huge column of stone to the top and sinking it to the base where it was to rest through the centuries to come.

MAN and modern science and machinery could transport the obelisk Cleopatra's Needle from Egypt to New York and set it up in Central Park, but how could the ancient Egyptians have erected their great monoliths weighing from a hundred to two hundred tons and more? Man power alone could not do it.

Now, after long research by Richard Engelbach for the British School of Archeology in Egypt, one method of the ancient builders has been learned. After the masonry base had been set a pit was built around it. This pit was filled with dry sand and the obelisk was dragged up and tipped into it, gradually sinking with its own weight as the sand was drained out through a tunnel at the bottom. The builders did not need actually to move the monolith, only to direct its movement, which required comparatively little power. When the pillar was set the works around it were removed, just as today scaffolding is removed from a completed building.

Artificial lightning bolts were hurled at this model tank filled with real oil. The wires caught the bolts, carrying them harmlessly to earth. Now real oil tanks are guarded in this manner.

Know Your Car

THE use of gaskets is a practical necessity in the commercial production of automobiles. The cylinder head, for instance, could be fitted to the cylinder block so that no gasket would be needed to make it a tight joint. To produce such a perfect joint, however, the top surface of the cylinder block and the lower surface of the cylinder head would have to be ground on a very accurate grinding machine and then a high-priced expert would have to spend hours in hand scraping any slight irregularities.

The gasket is used, therefore, because it can be compressed enough to take up the irregularities left by ordinary machining.

To get tight joints always use a new gasket. A gasket once used has lost the compressibility that makes a tight joint.

And because the only satisfactory gasket is one specially designed for the particular job, always use a gasket supplied by the car manufacturer.

"Lightning" Tamed in Test

MILLIONS of dollars will be saved for southern California oil operators, declares John M. Gage, of Los Angeles, by a method he has devised of warding lightning from tanks. Electric flashes are conducted harmlessly to earth by a novel system of overhead wires.

In a recent demonstration of his apparatus, described in last month's POPULAR SCIENCE MONTHLY, an oil-filled model tank guarded with wires was subjected to an electrical bombardment from a high-voltage machine, as shown at left. It failed to ignite. The wires have now been installed over large oil reservoirs, where they have proved successful.

Longest Arc Welded Pipe

WITH the welding of the 11,000th joint, workmen have just completed the longest electrically welded pipe line in the world, seen at the right—a forty-five-mile line of seven inches diameter to carry gas at 600 to 1,000 pounds pressure to the square inch across hilly, swampy, and wooded country from Lamkin to Hodge, La. Previously, oxy-acetylene gas welding was employed; but the electric method used throughout in the newest engineering feat is said to have effected marked economy. The pipe was laid in five-mile sections and each was tested under water or gas pressure before the work proceeded, only eleven pinholes developed in the thousands of joints. A final unexpected test occurred when a severe snowstorm exposed the line to a temperature of six degrees above zero before it could be buried; despite engineers' misgivings, it successfully withstood the ordeal.

The gasoline engine in the cart helps produce current for the greatest triumph of electric welding—a forty-five-mile Louisiana pipe line carrying gas at pressure up to 1,000 pounds per square inch.

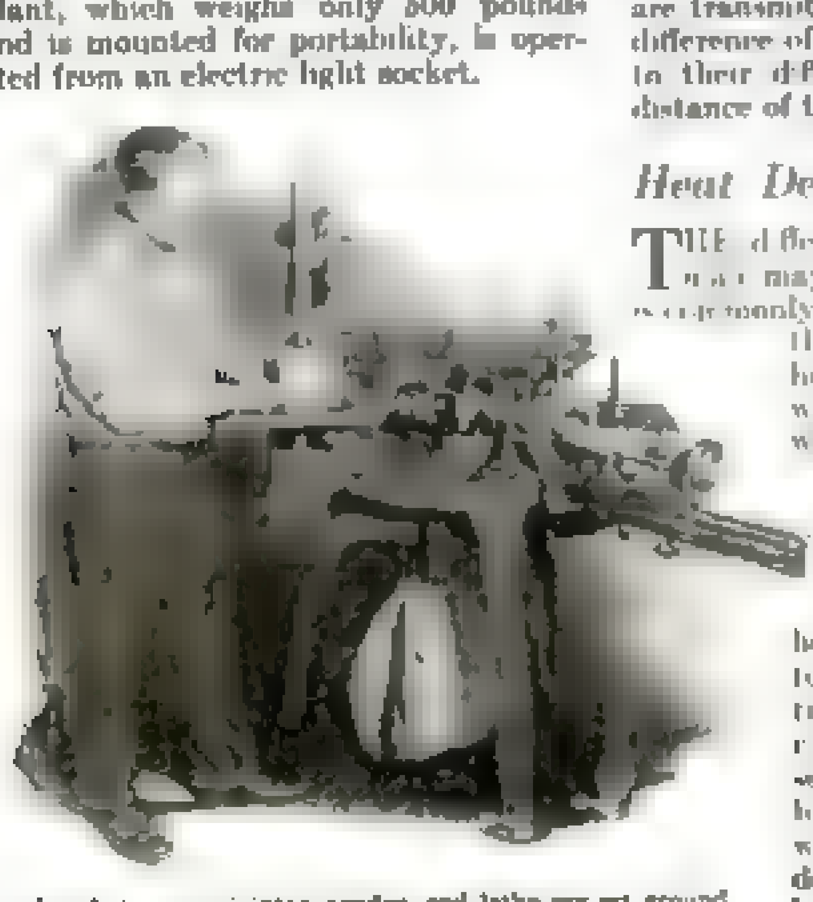
How Much Do You Know of the World You Live In?

Test your knowledge with these questions, selected from hundreds sent in by readers. Correct answers on page 112.

1. Where does the United States own a route for another canal between the Atlantic and the Pacific?
2. Where does chinchilla fur come from?
3. Where does chocolate come from?
4. In what country are the voters compelled to vote?
5. Where in North America is French the common language?
6. What lake is easiest to swim in?
7. What is the highest bridge in the world?
8. Where was the kimono invented?
9. What is the laughing jackass?
10. Where do the whirling dervishes perform?
11. What is the official starting point for distances in the United States?
12. What is the super-power system?

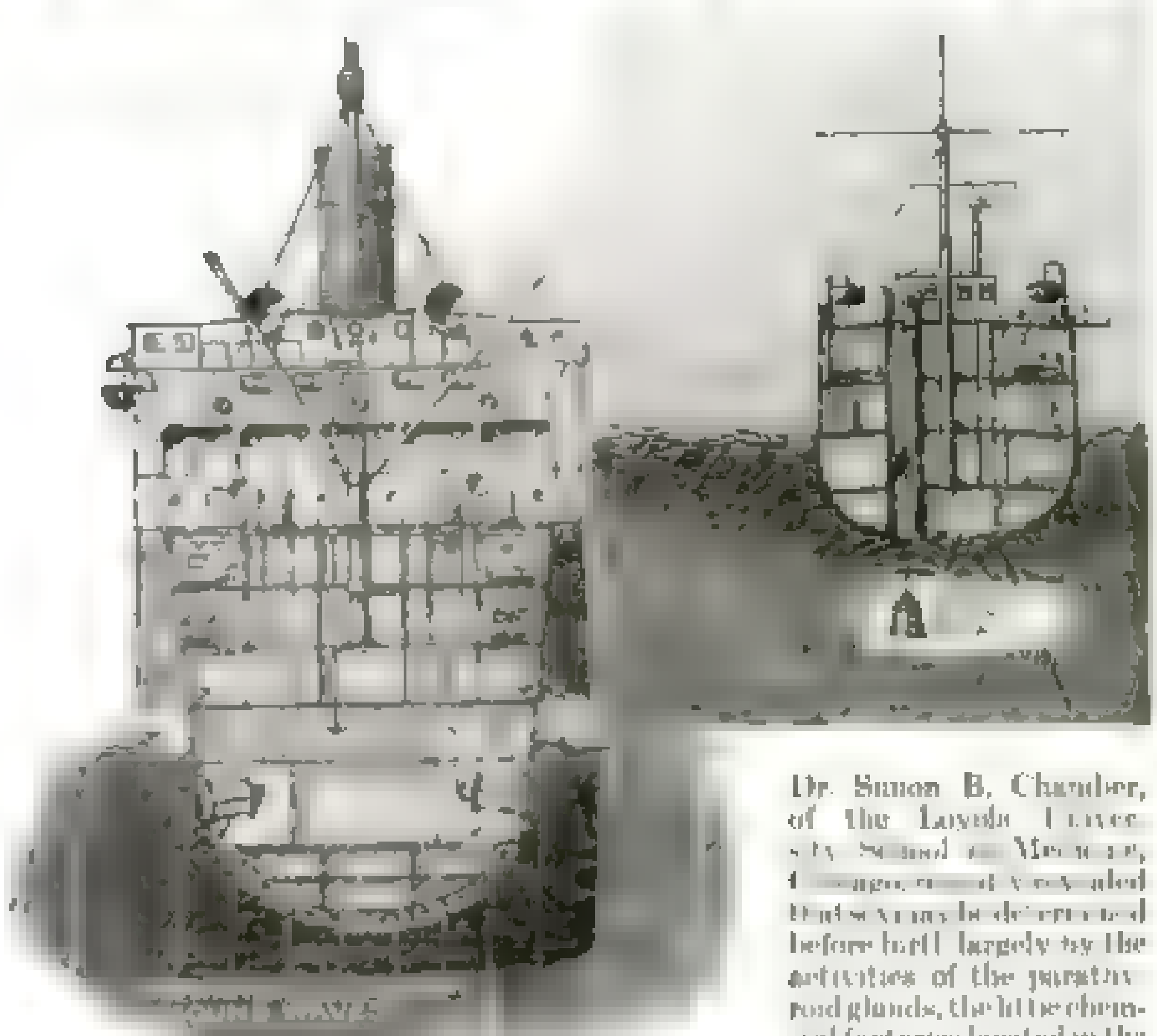
Five Machines Joined in One

AIMED at conservation of floor space and of power, thereby to reduce the costs of production, a new type of woodworking machine in which a band saw, jointer, rip saw, sander, and lathe are operated on the same table and by the same motor has been brought out by a Western manufacturer. The several machines are mounted on the edge of the table, and the motor is rotated about the axis of the table and moved radially to engage whatever unit is desired for use. Shifts are easily and quickly made. The plant, which weighs only 800 pounds and is mounted for portability, is operated from an electric light socket.



Band and rip saws, jointer, sander, and lathe are set around the edge of this economical woodworking table and a single motor in the center can operate each machine as it is needed.

Ships Talk Through Water by Sound Signals



HOW ships may talk together over moderate distances is shown in these diagrams of the latest type of undersea telegraph—a sounder that transmits code signals beneath the waves. Through a well in the center of a vessel is lowered an electric resonator that hurls its sound in all directions. All craft possessing the apparatus carry two sensitive receiving diaphragms on their hulls below the water line, and through these the signals are detected. When radio communication is also available, the distance between two ships is readily ascertained: radio and undersea signals are transmitted simultaneously, and the difference of time in their reception, due to their different speeds, indicates the distance of their sender.

Heat Determines Frogs' Sex

THE difference between male and female may not be so sharply drawn as is commonly supposed. In frogs, at least, the small difference between hot and cold may decide whether a wriggling tadpole will be masculine or feminine.

Emil Witschi, of the State University of Iowa, recently raised two broods of tadpoles from eggs. One brood he placed in water at natural temperature. One hundred turned out to be females and ninety-six males: a normal sex ratio. For the other brood he suddenly raised the water temperature to ninety degrees F. All these tadpoles became male frogs!

By experiments with rats, Dr. Simon B. Chamber, of the Loyola University School of Medicine, Chicago, recently revealed that sex may be determined before birth largely by the activities of the parathyroid glands, the little chemical factories located in the throats of human beings and lower animals. When these glands were removed from parent rats, the number of male in proportion to female offspring was doubled.

Light Waves Preserve Bread

IN AN article in our June issue, Frank Parker Stockbridge told how chemists' experiments with mineral salts in water saved a baker a million dollars a year, and produced better bread.

Now scientific research has discovered a way to improve the family loaf still further. According to President Hermann Schneider, of the University of Cincinnati, the bacteria which spoil bread a comparatively short time after it is baked can be destroyed by exposing them to light of a certain wave length. The result is that a loaf so treated can be kept good for at least eight days.

The same process has been used successfully to destroy the bacteria that spoil milk, orange juice, and other foods.

A Man-Made Aurora Borealis

ENGINEERS dissolved much of the mystery of lightning when they shot artificial thunderbolts across a room.

Another spectacular mystery of Nature, the Aurora Borealis, now is giving up its secrets in a similar way. At Princeton University Dr. Gunther Carlo, of the University of Gottingen, Germany, and Dr. Joseph Kaplan, of Johns Hopkins, recently produced an artificial Aurora and discovered that electricity, discharged in a mixture of oxygen and nitrogen under certain conditions, creates the beautiful red and green northern lights. By further experiments they hope to prove that the transfer of nitrogen energy into oxygen produces the display.

Clock Times 20 Men at Once

WHEN separate experimenters in a laboratory formerly sought at the same time to test the muscular reactions of one subject, a costly and elaborate clock was required by each one. Now Dr. O. G. Harne, of the University of Maryland, has devised this single clock that times as many as twenty distinct experiments conducted simultaneously. If any experimenter in the room desires a record in minutes, seconds, or split seconds, he adjusts four buttons on the clock that corresponds to his particular table. Without further attention the ingenious clock measures the time it takes his subject's muscles to respond to light flashes or to spoken suggestions. More than a dozen other universities, recognizing its value, have asked for copies of Dr. Harne's device, it is reported.

What "Fair" Weather Means

THOSE who have grumbled about seeming inaccuracies in weather forecasts—particularly those disappointed by a gloomy day following a "fair" prediction—may be illuminated by a recent announcement of the U. S. Weather Bureau. "Fair," it explains, need not mean a sunny day in the Bureau's use of the term, which includes everything from "clear" to "cloudy" and "partly cloudy," all three being further qualifications of the fair prophecy. In its strictest sense, at the Weather Bureau, "fair" signifies a day on which not more than .01 inch of precipitation—the veriest sprinkle or snow flurry—is expected.

Elephants Taught to Plow

EXPERIMENTAL government elephant farms have been instituted in the Belgian Congo, where the giants of the animal kingdom are trained to plow—a service they perform at a fourteenth the cost of plowing by tractor. Baby elephants, from two to ten years old, are singled out from wild herds, captured, and taught to do useful work by expert elephant men with the aid of already-trained older elephants. One elephant can plow two and a half acres in two days.

Meters Read over Phone Wire

ELECTRIC current meters report their own readings over ordinary telephone wires through a new device called the telemeter, developed by the General Electric Company. Although the new system has not yet been developed to the point where it will read your household meter and replace a call by the man from the electric company, it has already been successfully installed in the substations of a great electric power concern. Sitting at his desk, the chief dispatcher can see on dials before him how much electricity is being used, or is required, at any of the links in the extensive power network. Telephone service is in no way interfered with by the new device, though it uses the same wires in order to save the expense of additional circuits.

Lathe Made of Old Car Parts

OUT of discarded motor car parts, Hoyt E. Van Buren, of San Francisco, manufactured the lathe on which he turns out unusual pieces of woodwork. Pistons serve as bearings, and the two spindles were turned from an axle. The faceplate was a locomotive boiler check. Among Van Buren's productions are an exquisite inlaid box which he presented to Mrs. Coolidge, and a piece of spiral work constructed from directions in POPULAR SCIENCE MONTHLY.

A Three-Mile Motor Tunnel

WITH the recent piercing of the last section of rock between the two tunnel headings proceeding from opposite shores, England is well on its way to completion of the world's largest motor tunnel—a great shaft beneath the Mersey River that will link Liverpool to Birkenhead. At present indications, it will be finished and opened to traffic in 1930.

Three miles long and forty-four feet wide, the huge tunnel will accommodate four traffic streams totaling 3,000 vehicles an hour. High- and low-speed traffic lanes will be marked off, and all cars will be required to keep 100 feet apart.

Copper Cures Anaemic Rats; Experts Plan Tests on Men

STRIKING cures of anaemic rats by feeding them compounds containing copper were recently reported to the American Society of Biological Chemists by Dr. E. B. Hart and other chemists of the University of Wisconsin, who may have discovered in the red metal's compounds, of which traces are found in milk and other foodstuffs, an important new cure for human sufferers.

Previously it had been supposed that iron alone was effective in restoring to blood its healthy red color that signifies the presence of the vital oxygen-bearing substance, hemoglobin. But Dr. Hart found that pure iron materials of laboratory manufacture did not cure anaemia in rats, though natural, impure iron compounds did. A pale bluish color, typical of burnt copper compounds, in the foodstuffs he prepared from natural iron substances gave a clue to the discovery that copper was the mysterious agent needed. Its action is still not understood, but Dr. Hart has established that both iron and copper are needed to check or prevent anaemia in rats. At certain hospitals he plans to test his discovery on men.

Spade and Fork in New Tool

FORK and spade are combined in the new French tool of many uses illustrated below. For turning soil, the fork alone is used; when work with a shovel is to be done, a flat plate is slipped over the fork and it becomes a spade. A crossbar on the novel tool's handle provides a better leverage for twisting it free with a load of turf or roots, and saves much back-breaking labor.

When a metal cover is slipped over the tines of this new French garden fork it becomes a spade. A cross baron the handle gives increased leverage.

Dirigible Los Angeles *Costs $500,000 a Year to Operate*

DIRIGIBLES as economical craft are hardly yet to be recommended to private owners, judging from a glimpse at Uncle Sam's bill for running the huge *Los Angeles.* Operation during the fiscal year 1927 cost a little more than half a million dollars—$505,108, to be exact. Maintenance and running alone, exclusive of pay for the ship's crew and the upkeep of its Lakehurst, N. J., home hangar, amounted to nearly $272,000.

Leviathan *Sets Speed Record*

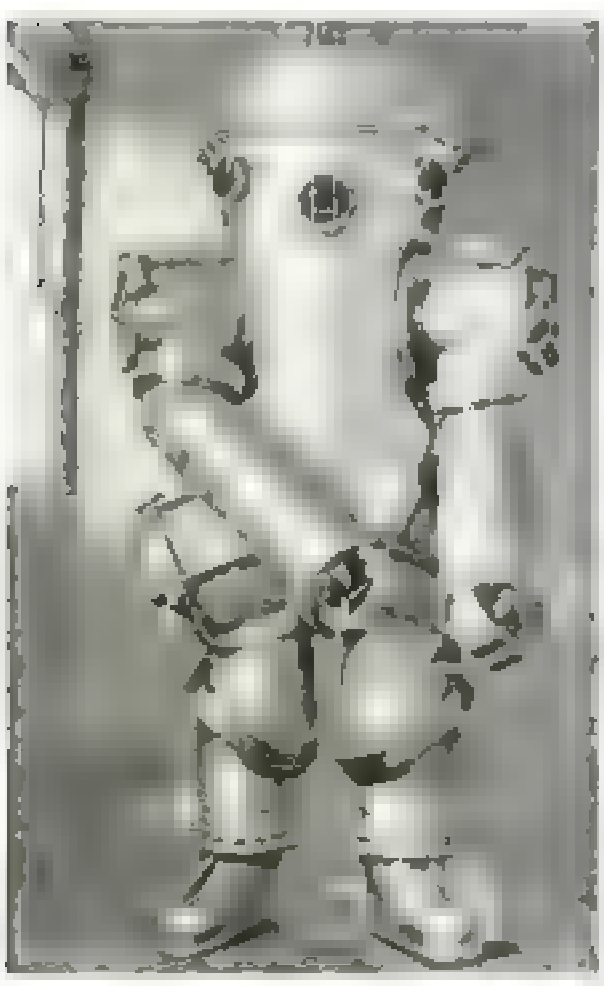
BY ATTAINING a speed of thirty knots, equivalent to 38.4 land miles an hour, the 60,000-ton American ship *Leviathan* recently set what is believed to be a new speed record for large ocean liners. Aided by a following wind, she held the speedy pace for several hours. Records credit the British liner, *Olympic,* in 1924, with a high speed of 27.8 knots.

Diving Suit to Recover Gold

SOME of the $250,000,000 that lies in shipwrecks at the bottom of the sea may now be recovered through an invention of H. L. Bowdoin, of Whitestone, N. Y., seen below—a metal diving suit whose wearer can venture into hitherto unattainable depths. He says he has achieved a world's record by going down two hundred feet and remaining there for forty-five minutes.

The terrific water pressure is withstood by an ingenious arrangement of metal armor with jointed plates. Within is a suit of rubber for the diver himself. A tube of coiled steel wire incloses the air hoses. Steel claws enable the wearer to pick up objects as small as three-quarter-inch nuts.

The first practical test, Bowdoin says, will be an attempt to salvage war wrecks at the bottom of the English Channel. He will donate his invention to the U. S. Government as life-saving equipment in submarine disasters.



H. L. Bowdoin's new steel diving suit, resisting water pressure at lower depths than ever before, which may help recover gold from sunken vessels.

Wind Resistance of Houses

THAT a half-completed structure, of open framework, may offer more resistance to the wind and suffer greater danger of destruction than the same finished dwelling was a surprising fact revealed by recent tests of models in a wind tunnel at the Kansas State Agricultural College. Owners of houses in tornado or hurricane areas are advised to equip them with indestructible window shutters by Prof. E. R. Dawley, who made the tests. Otherwise, he said, the broken windows would leave apertures that would increase danger of demolition.

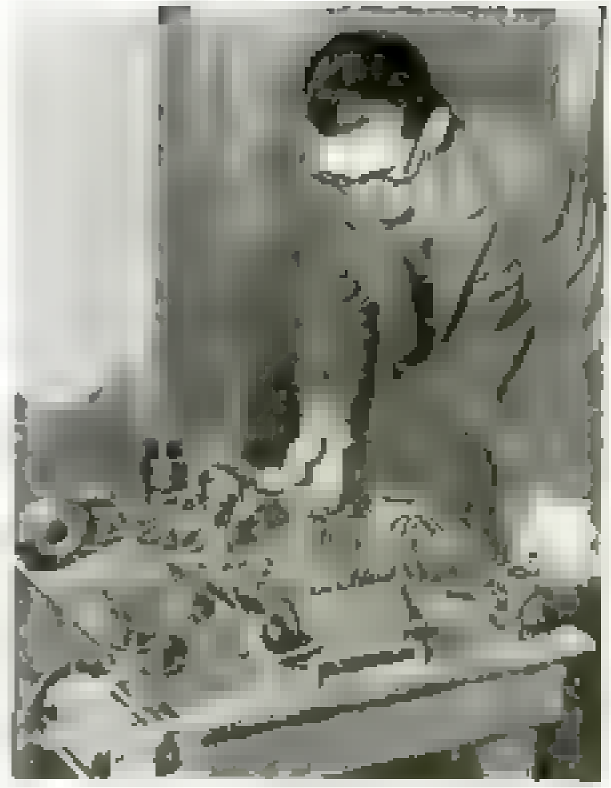
In the tests Prof. Dawley used what he believes is the largest model building ever tested—a toy dwelling covered with fiber wall board that was four and a half feet long and nearly four feet high.

Auto Exhaust Fights Gophers

CARRYING the war on gophers into their underground homes by attacking them with the poisonous gases from the exhaust of an automobile is announced by W. H. Carr, an oil company official at San Jose, Calif., who employs this means of ridding his lawn of the rodents. A common garden hose is fastened to the exhaust outlet of the car. The nozzle, poked into the hole, injects the gases and prevents the gopher's escape.

Dress an Engineers' Problem

FREE ventilation for the skin is vital for hot weather comfort, declares E. R. Clark, fellow of the Mellon Institute of Industrial Research at the University of Pittsburgh, who has just subjected underwear design to searching analysis. Using mathematical methods, including calculus equations that engineers employ in studying heat loss and evaporation, he maintains that the question of keeping the body cool is essentially like any other engineering problem. Loose-fitting underwear made chiefly from cotton fabric is the best ventilated and hence the coolest, he concludes.



"Ham" Uses New Radio Band

BY A new feat in amateur radio—a cross-continent talk on the remarkably low wave length of ten meters—Charles K. Atwater, radio experimenter of Upper Montclair, N. J., has added another triumph to those of radio's "hams." He was recently successful in establishing two-way communication on this wave, using low power, with two amateur stations on the Pacific coast. Previously, also on ten meters, he had repeatedly conversed across the Atlantic with a French amateur at Arachon, France.

Atwater is seen in the photograph with his ten-meter transmitting set—a part of his amateur station.

These successes open a new radio channel—the "experimental" ten-meter band which radio engineers had long considered useless for long-distance transmission. Radio amateurs already had been the first to develop the use of waves as short as twenty meters, now of known worth for world-wide radio.

Prize Offer for Moon Flight

IF JULES VERNE, famous imaginative novelist, were living, he might be surprised to hear himself called a professor of "astronautics."

That is the new name for a branch of science which has captivated men's imaginations for centuries—that of finding a way to journey through space to the moon, or Mars, or other heavenly bodies.

That scientists now regard the study of astronautics as much more than a daydream is evidenced by the fact that the French Astronomical Society has just offered an annual prize of 5,000 francs (about $200) to the person contributing most toward solving the problem of celestial transportation. The prize is sponsored by foremost French astronomers and physicists.

After flyers have spanned all the perilous distances of the earth, there will still remain other worlds to conquer, other opportunities for adventure and fame.

Most Gigantic Incandescent

LIKE a radio tube in appearance is the world's largest electric lamp—a monster 50,000-watt experimental bulb just built by the General Electric Company and exhibited at Nela Park, Cleveland, Ohio. At the top of the bulb, a radiator made of metal fins carries off intense heat generated by the white-hot tungsten filament, which burns at a temperature of 5,500 degrees Fahrenheit—twice as hot as molten steel. The bulb is filled with nitrogen gas, whose circulation cools it and carries upward into the radiator "evaporated" or thrown-off tungsten particles from the filament, thus preventing blackening of the walls.

Although the present lamp is intended simply for a test by its designer, D. K. Wright, shown here with it, such huge lights ultimately may be used for airport lighting and for the illumination of motion picture studios.

Oil Burning Motor Meets Test

HEAVY oil for airplane fuel, to replace costly and dangerous gasoline, is brought nearer by a new oil-burning motor recently demonstrated by the National Committee for Aeronautics at Langley Field, Va. Not only is oil fuel cheaper, but it practically banishes fire hazard; it will actually extinguish a flame, until heated to a very high temperature within the motor's cylinders.

Though the advantage of such a motor has long been conceded, the difficulty has been to obtain one light enough for airplane use. Now the National Committee for Aeronautics exhibits the result of five years of constant experiments—a one-cylinder, twenty-six-horsepower model that develops one horsepower for every three pounds of weight. This ratio, the best thus far developed, is not far inferior to that of many gasoline airplane motors now in use, and it is announced that the construction of multi-cylindered oil engines on the same principle will commence at once.

Black Sheets Induce Sleep

BLACK bedclothes and pillows in a black bed, within a room of the same dusky shade, is the unusual cure for insomnia suggested by recent experiments of Dr. Mario Ponzo, of the Hospital for the Insane at Alessandria, Italy. In such a room, he says, many of his most violent patients became calm and soon fell into a deep, natural sleep. Even in ordinary cases of insomnia the same treatment may be beneficial, Dr. Rudolph Katz of Berlin suggests.

Thinking with Half a Brain

MANY brain specialists—notably Dr. Frederick Tilney of New York City—believe the human brain is used only to a small fraction of its capacity. Now that opinion seems upheld by five remarkable operations performed recently by Dr. Walter E. Dandy, of Johns Hopkins University. In each one Dr. Dandy removed a full half of the cerebrum, or "thinking portion" of the brain from a supposedly hopelessly diseased patient. Three patients recovered and tests showed their intelligence wholly unimpaired. However, as expected, permanent paralysis of half the body occurred.

Campbell Plans New Effort For Automobile Speed Mark

MAJOR MALCOLM CAMPBELL, England's premier speed driver, has announced he will try again for the world's auto speed record, which he so lately won only to lose again, even if he must return to America to do it. The announcement followed the recent refusal of the Royal Automobile Club to permit his proposed attempt on the Pendine Sands, in Wales, a seven-mile stretch of beach that is declared to be too short for high speed racing.

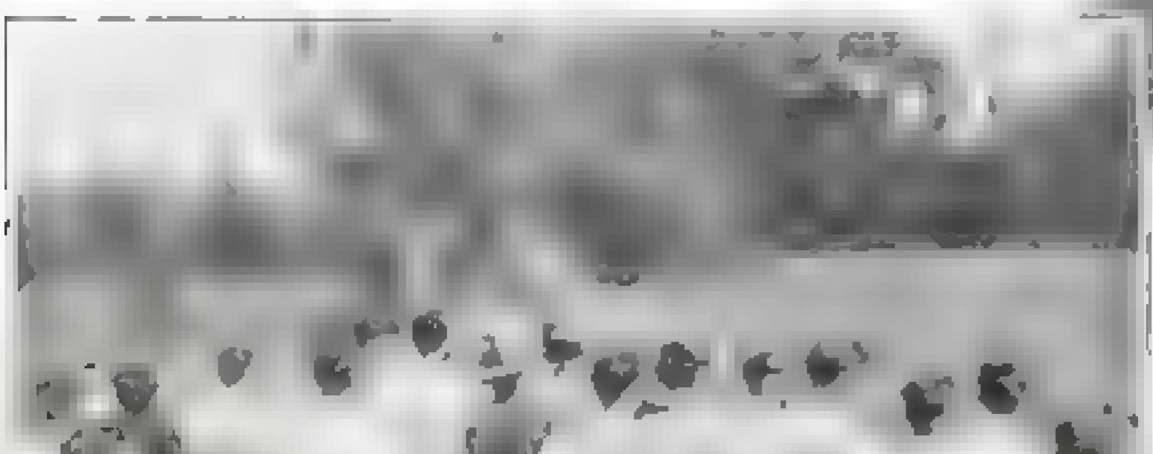
Tragedy had stepped into the international speed rivalry not long before, when Frank Lockhart, American, seeking a new record at Daytona Beach, Fla., was thrown from his Stutz Special and killed when it blew a tire, traveling at a 200-mile clip. A few days earlier, on the same course, Ray Keech, driving the special-built thirty-six-cylinder car of J. M. White, Philadelphia sportsman, had gone 207.5 miles an hour—bettering Campbell's short-lived record of 206.9 miles.

New Explosive Beats TNT

MIGHTIER than TNT, high-power explosive, is a new light-green powder known as "radium-atomite" recently demonstrated at the California Institute of Technology, of which radium is said to be one important ingredient. In the tests shown here, representatives of powder companies, and of the Institute's Reserve Officers' Training Corps, saw small charges of the new powder, of TNT, and of dynamite—a third of an ounce of each—placed in separate 700-pound lead jars and exploded. This showed the radium powder's explosive power, measured by the expansion of its gases, far greater than that of its two competitors.

Capt. H. R. Zimmer, Los Angeles chemist and former Army officer, who invented the new explosive, did not permit Institute chemists to analyze it. He said the U. S. War Department might wish to keep its composition a secret.

Lieut. Col. L. M. Adams (left) and Capt. H. R. Zimmer, inventor of the new explosive, setting charges of it and other explosives.



A tiny charge of radium-atomite, mighty new explosive, caused this upheaval and showed its unprecedented power in experimental blasting at the California Institute of Technology. The secret of its composition is known only by its inventor and the War Department.

Sixty-Hour Trans-Atlantic Speed Boat Ready to Go

Adrien Remy's ocean glider which promises new speed marvels is ready for launching on the River Seine. The photograph at the right shows the graceful lines of its large pontoons.

The photograph below shows how the cabin, with a 650-horsepower engine, is carried between pontoons. Water propeller substituted for air propeller lifts the craft partly out of the water.

NOT long ago the little French town of Javel, on the river Seine, looked and marveled at the strangest water craft it had ever seen. It had just been trundled on heavy trucks from the marine works at Saint-Ouens, and assembled on blocks for launching. Among the curious crowd stood its inventor, Adrien Remy, watching his dream come true. It was an "ocean-glider," he said, with a tanklike engine room and cabin swung on a steel framework between two cigar-shaped pontoons that would carry it safely through the fiercest Atlantic storms he might encounter.

Such was the craft, he said, in which he would dash from France to America in sixty hours. He had planned to do it in April, but his dream-ship was not quite finished. Now it was complete, ready for its trial trip in salt water. Assured of its seaworthiness, he would take on his crew of six men, seal the narrow portholes, and start his speed-mad dash to New York.

Outwardly it resembled closely the original six-foot model that its inventor had exhibited a year before. A few changes—for instance, the substitution of round pontoons for the flattened ones in the first model, to make their manufacture easy—adapted his first plans to practical realization.

Within the engine room rested a 650-horsepower gasoline motor to send the craft skimming like a hydroplane. Remy had substituted a water propeller of unconventional design for the air propellers that he had first intended to use. It would have the advantage of lifting the craft part way out of the water and increasing its maximum speed. Although the fastest ocean liners can reach a pace of only thirty knots, Remy's ship was designed to attain seventy knots—equal to nearly eighty miles an hour—in calm water and forty to fifty knots when the going became rough.

Such an ocean-glider as his, Remy points out, could outdistance any liner and serve as a fast dispatch boat for mail and for passengers. It would even compete successfully with future ocean-going airplanes, the inventor declares, because it could outride storms that would imperil them. In fact, he claims his craft to be practically unsinkable in any weather.

On his trial trip across the Atlantic, from Cherbourg to New York, Remy planned to take a crew of six men, food for ten days, and wireless apparatus to communicate with passing vessels. A successful arrival in New York would be followed by the construction of larger ships on the same pattern.

Ford, Lawrance and Elmen Receive Medals

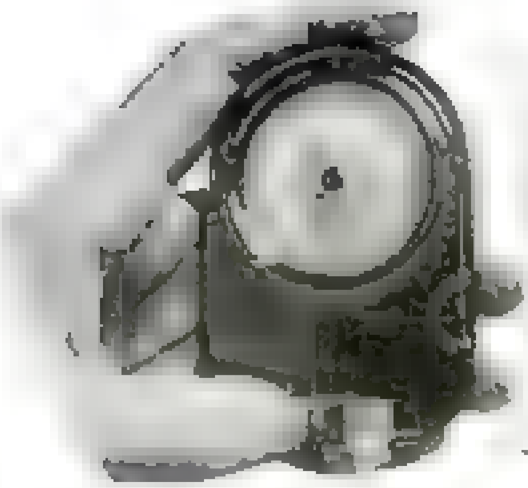
FOR his "rare inventive ability" which enabled him to effect high-speed production of automobiles, Henry Ford has just received the Cresson Medal of the Franklin Institute. Similar awards went to Gustaf W. Elmen, discoverer of the highly-magnetizable nickel compound "permalloy," and to Charles L. Lawrance, inventor of the Wright Whirlwind airplane motor. Orville Wright, pioneer airman, was present at the Philadelphia meeting where the medals were presented.

The presentation of the Cresson Medal to Mr. Ford was not only in recognition of his inventive ability but "for revolutionizing the automobile industry and for his outstanding executive powers and industrial leadership."

Among other awards made were these: Cresson Medal to Vladimir Karapetoff of Cornell University for invention of instruments for the mechanical calculation of magnetic and electrical constants of an electrical transmitting line; Henderson Medal to William F. Kiesel of the Pennsylvania Railroad for improvements in locomotives and railroad equipment. Walton Clark Medal to Arthur Graham Glasgow of London for improvements in manufacture of illuminating gas; Potts Medal to William E. Taylor of Corning, N. Y., and his associate, Eugene C. Sullivan, for development of pyrex, a heat-resisting glass, used in cooking.

Left to right: Henry Ford, Dr. H. McClenahan of Franklin Institute, Charles L. Lawrance, and Orville Wright. Ford and Lawrance are receiving medals for inventions.

Old Needs Met in New Ways



Gage Measures Diamonds

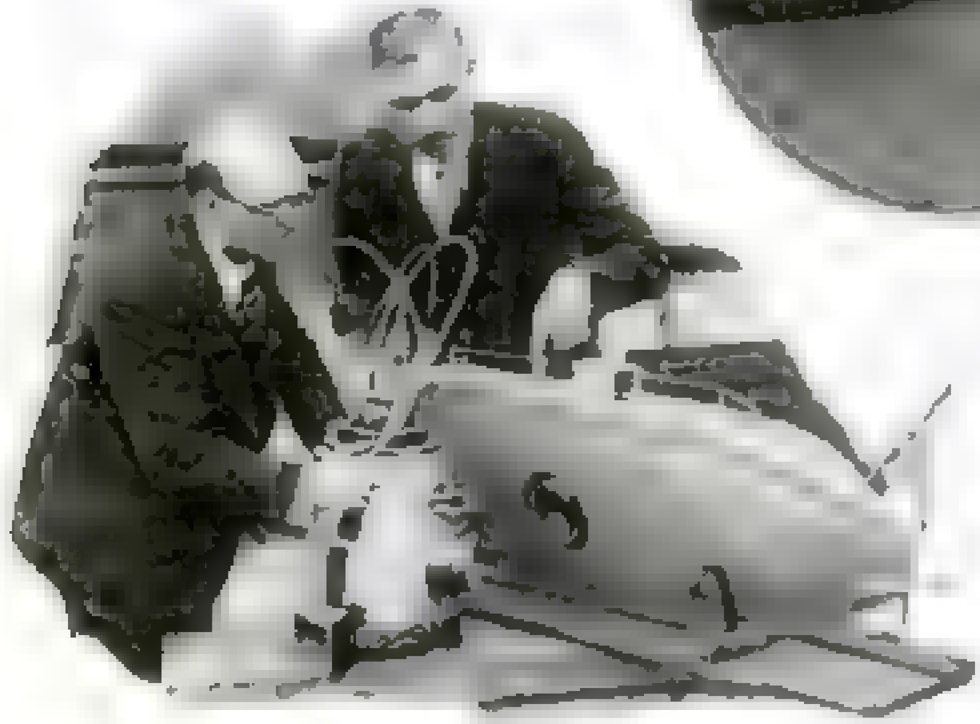
In measuring and cutting rare jewels precision is of the greatest importance, and this invention of a diamond specialist registers all dimensions down to a tenth of a millimeter. It gages also the bezel, the part of a jewel between top and girdle.

Nonsplitting Wood Nails

Newly designed nails for cabinet making are flanged and triangle shaped so that they cut their way through instead of forcing it. The improved and ordinary nails are shown in the photograph.

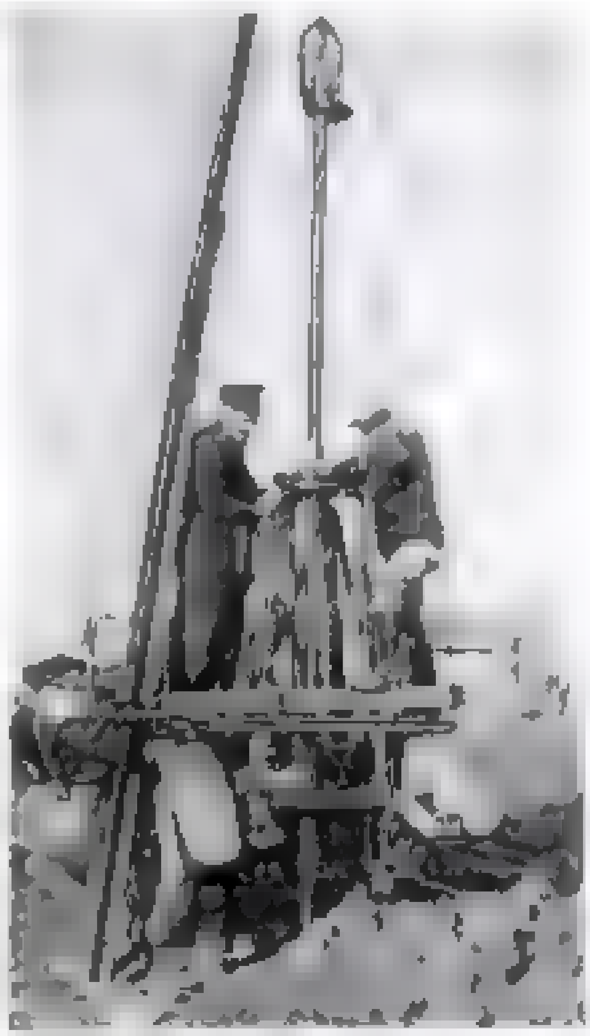
Telephone Lock

A new French device to prevent unauthorized persons from using your telephone is a lock so attached to the wires that a call cannot be made except while the keys which are held by the rightful users are inserted.



Diving Bell as Submarine Aid

Success of the [illegible] of a [illegible] diving bell in rescuing men trapped in sunken submarines have been offered to the Navy by the inventors, Dean Fischer and John Kurdys, shown here [illegible] the [illegible] The [illegible] through [illegible] the crew [illegible] which [illegible] their way.

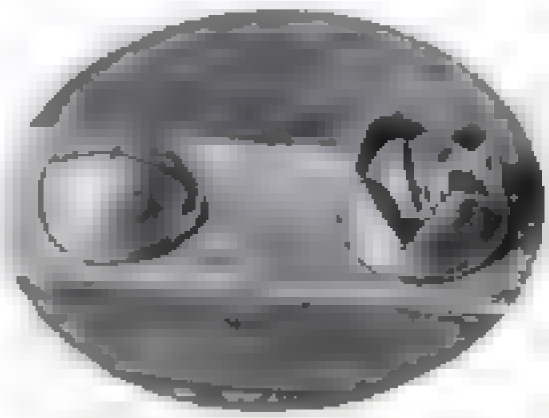


Portable Drill for Oil Wells

Prospectors for oil and minerals may go anywhere with this new machine attached to the end of a motor car or truck. The drill, driven by the automobile's engine, is said to go 1,000 feet a day through hard rock. When the motoring treasure hunter finds a likely spot he starts quick action.

Noise-Proof Walls for Radio

Seeking the best sound-proof walls so that a radio in one room disturbs no one in the next, the U. S. Bureau of Standards sets up panels of various kinds of walls and measures the sound that penetrates them. The pictures above and at left show some panels and the measuring instrument.



Giving Screw Heads a Finish

A crown to prevent screw heads in chairs or elsewhere from tearing clothing is a washer that fits under the head. After the screw is driven home the four corners are bent over the head as shown.

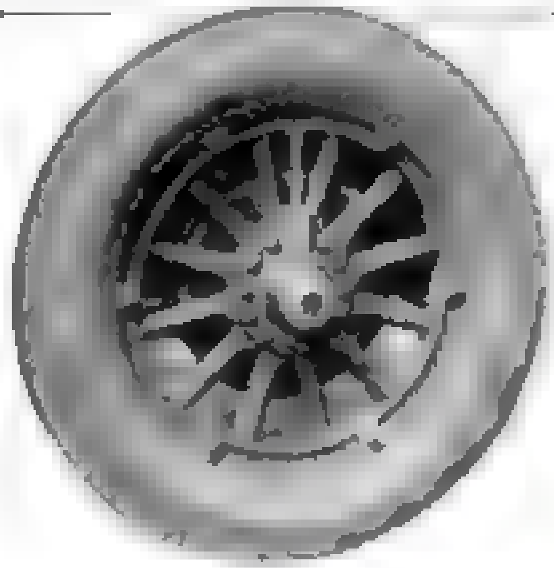
Little Ideas to Help the Motorist

New Pedal Jack

One hand operates this tool without gears, ratchets, or handles. It is used to adjust brake and foot pedals to any desired position or pressure.

Glare-Proof Mirror

A "night mirror" of black glass, is said to absorb the glare of the lights of the car behind you.



Wheels Pump Own Tires

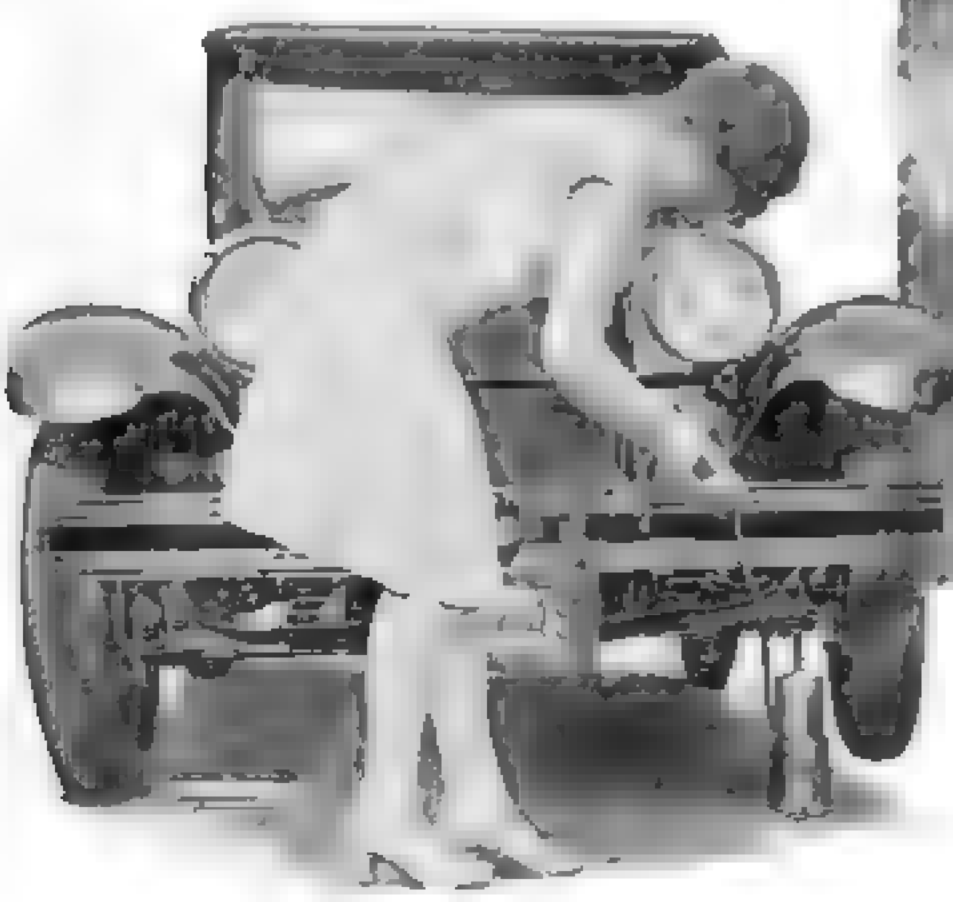
When one end of this device is attached to the wheel hub and the other to the tire valve an eccentric gear gives the piston inside one stroke each time the wheel turns, sending air into the tire. A safety valve, set to the correct pressure for the tire, releases surplus air.

Pedestrians Direct Traffic

Los Angeles is installing at dangerous crossings traffic signals that street users can operate by pressing buttons. When you push a button a red stop light holds up traffic to let you cross the street and another lamp on the signal standard floods your path with a beam of light.

Research for Ideal Headlight

With this device the National Lamp Works, of Cleveland, flashes lights with all sorts of lenses and reflectors on a screen and then measures their rays and their diffusion.



Air Lifts Auto

Put this jack under the axle and compressed air from a flask, several of which go with it, flows into the mechanism, elevating the car. A service station air hose will also operate it.

Motorcycle Like a War Tank

With this machine, which has two wheels and a caterpillar belt in the rear, the rider can drive through fields and woods as well as along roads. Instead of turning the front wheel to steer, the operator moves it more easily by a system of levers. The British Army is experimenting with the machine and may adopt it for some infantry units.

Keeping Pace *with* Advances in Aeronautics

Lindbergh Tests Imported Flivver

COL. CHARLES A. LINDBERGH is seen above testing the latest in flivver planes, a Klemm monoplane of German design that weighs but 600 pounds, has a wing spread of forty-three feet, and is driven by a two-cylinder twenty-horsepower motor. Back of Lindbergh is his attorney, Col. Henry Breckenridge. It can fly 500 miles on the ten gallons of gas it carries.

George Kern, Jr., New York retired business man, bought a Klemm plane and flew it across the Alps and 3,000 miles over Europe at a total cost of $160. It was he who brought the tiny monoplanes to America. The Ford flivver plane is of similar weight and smaller wing spread with a forty-horsepower motor.

Cost of Helium Gas Slashed

NONINFLAMMABLE helium gas used to inflate balloons and dirigibles, valued before the war at $1,700 to $2,000 a cubic foot, now costs a little more than four cents for the same quantity, according to Director Scott Turner of the U. S. Bureau of Mines.

Even this low price is a rise from three and a half cents last year—caused by the approaching exhaustion of the Petrolia, Tex., gas field where it is obtained. But a projected helium plant at Amarillo, Tex., will provide ample helium for the two new 6,000,000-cubic-foot dirigibles that Congress has authorized and for those already constructed besides.

5,000 Landing Fields

FIVE thousand landing fields now are available for the increasing number of airplane pilots in this country, according to the U. S. Department of Commerce. California leads, with 115. Most modern, however, in proportion to their number, are Wyoming's, of which seventeen out of twenty-one are equipped with beacons and flood lights for night landings. Texas is second in number of fields, having 90. Pennsylvania has 68, Illinois, 58, Ohio and Oklahoma, 43 each. Pennsylvania leads in airports, having 24.

Map of the Transcontinental Air Transport combined rail and airplane trip, cutting in two the four-day train trip from coast to coast. Col. Lindbergh is technical director of the organization

Two-Day Air-Rail Line to Span U. S.

WITHIN a few months at most you will be able to pass from coast to coast in only forty-eight hours by rail and air, cutting the fastest transcontinental time in two. That much is promised by a newly formed $5,000,000 concern, Transcontinental Air Transport, Inc., which merges the combined facilities of the National Air Transport and the Pennsylvania and Atchison, Topeka and Santa Fe Railroads. C. M. Keyes, president of the Curtiss Aeroplane and Motor Company, heads the new air-rail organization, of which Col. Charles A. Lindbergh has become chief technical expert.

This latest development in transportation was forecast in POPULAR SCIENCE MONTHLY last December in an article by William P. MacCracken, Jr., Assistant Secretary for Aeronautics of the U. S. Department of Commerce.

According to the first tentative schedule passengers leaving New York will make a night trip by Pennsylvania train to Columbus, O., and leave in the morning on a ninety-mile-an-hour passenger plane for Wichita, Kan. There they will transfer to a Santa Fe train for another overnight trip to New Mexico, and thence make the last daylight lap to Los Angeles by another tri-motored airplane. Night flying is avoided. The fourteen passenger planes are luxuriously equipped and meals served.

There will be similar eastward service and eventually the plan will be extended to other cities. Night flying is also contemplated for later service. A coast-to-coast air-rail ticket will cost about

The new giant tri-motored Fokker cabin monoplane, built for the de luxe service between Los Angeles and San Francisco, of the Western Air Express. The scene is at Mitchel Field, N. Y., just after Colonel Lindbergh and other aviation leaders had witnessed a test flight and just before Lindbergh himself took up the plane.

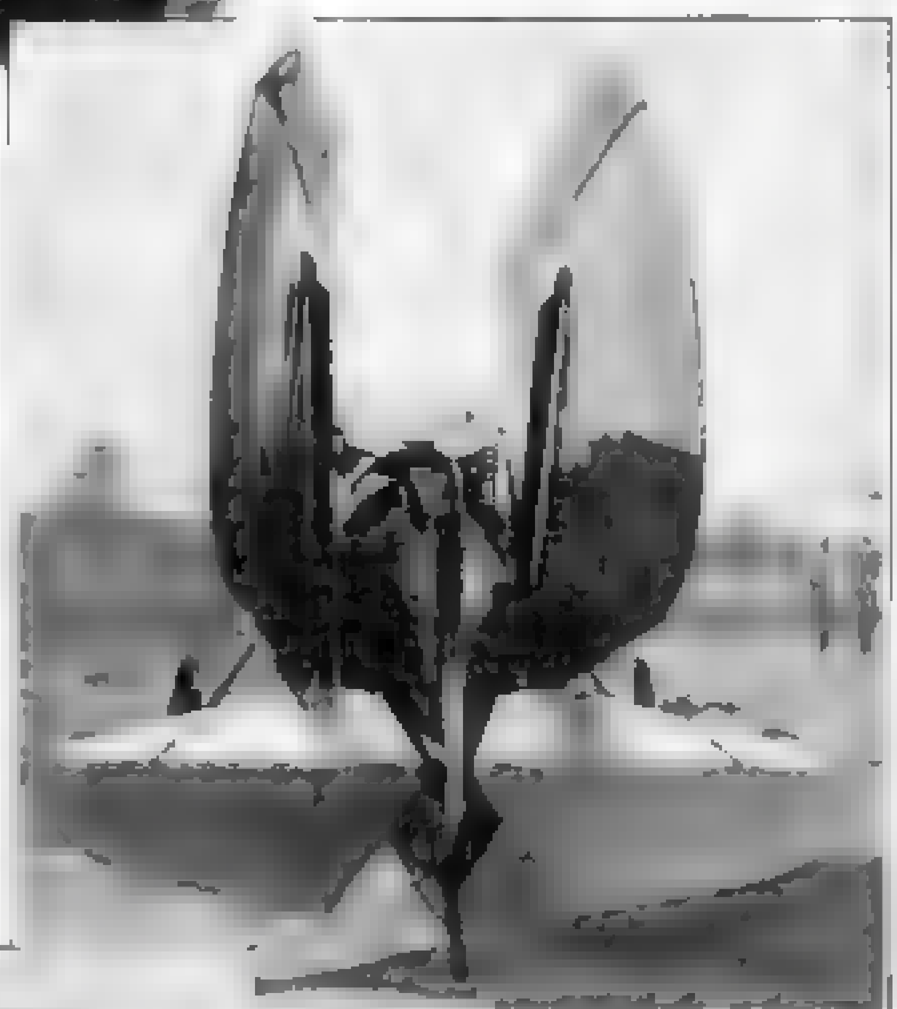
Passengers photographed 5,000 feet in air in the new Western Air Express Fokker on the test flight. Among them are Harry F. Guggenheim, Admiral Cone, Dr. W. Klemperer and Captain Bender.

two and half times as much as the present all-rail fare.

Col. Lindbergh, chairman of the technical committee of the organization, who quickly began surveying routes, will supervise choice of air routes, selection of equipment, and all matters of a technical nature. Veteran pilots will assist him in his first commercial post since he flew to Paris—a position that will not, however, preclude any future air ventures, he says.

Autogiro in Speed Feat

REPORTS from England state that in its latest form the Cierva "autogiro," an experimental plane that uses an idly-revolving windmill for wings, shows amazingly capable performance when compared with standard aircraft, together with important advantages all its own. Unofficial figures claim a horizontal speed of ninety-five miles an hour for the autogiro; it has a climbing speed, it is said, of 400 feet a minute. As told in previous numbers of POPULAR SCIENCE MONTHLY, its use of a "windmill" instead of wings makes it possible for the craft to land virtually in a vertical line, much like a parachute, with no final run along the ground—a valuable feature where landing space is limited.



The latest folding monoplane, which, with a wing spread of 35 feet, a 100-horsepower motor and a speed of 120 miles an hour, can be collapsed into a space 8 by 9 by 25 feet. The machine is called the only foolproof aircraft. It was built by W. B. Kinner for Dr. T. C. Young, Chairman of the 1928 National Air Race Committee.

Moving an airplane in Berlin with the remarkable new "strut car" invented by Gootwald Muller, a German expert. The machine, operated by storage batteries, lifts the plane by its tail strut. Then the operator can pull or shove the car and plane wherever he wishes.

Dirigible Lands on Liner

A FEW days ago the nonrigid army airship *TC-5* caught up with the steaming vessel *American Trader*, landed upon its afterdeck, took on a bag of mail, and deposited it an hour later at the Lakehurst, N. J., naval air station. The successful experiment, in Lower New York Bay, was the first recorded instance of a dirigible's landing upon a commercial vessel, and demonstrated the feasibility of transferring last-minute passengers and mail from a "blimp" to an outbound ship, or speeding the arrival of incoming voyagers and letters. Ship-to-shore flying by airplane was demonstrated last year by Clarence Chamberlin, trans-Atlantic air pilot. By landing on the aircraft carrier *Saratoga*, not long ago, the great dirigible *Los Angeles* had shown that a lighter-than-air ship might accomplish the same feat. While the *American Trader* steamed ahead at six knots, bound for England, the *TC-5* landed and was moored upon a specially-built thirty-foot steel platform on the afterdeck. Three minutes later the airship took flight for the shore.

Giant High Altitude Camera

SIX miles above the earth—far beyond the reach of antiaircraft guns—a plane equipped with the newest aerial camera can take pictures of the earth that reveal the smallest details, even houses, trees, and roads. (Continued on page 128)

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In the United States and its possessions and in Canada, twenty-five cents the copy; $2.50 the year. In all other countries $[illegible] the year. Changes of address must reach us five weeks before the next date of issue [illegible], with the new address, the one to which the magazine formerly was sent.

A Blind Man's Vision

FIFTY-SIX years ago, Edward Livingston Youmans, a blind man, established POPULAR SCIENCE MONTHLY. He saw in science "not the mystery of a class, but the common interest of all rational beings." He promised to appeal, "not to the illiterate, but to the generally educated classes," to the end that they might get more out of life.

Today, we can look back over the years and see his vision come true, his promise kept. Science has been freed from the shackles of the high priesthood that controlled it, and made understandable to all of us. The marvels that serve us on every hand, making life richer than ever before, are a tribute to the vision of the blind genius.

The policies he laid down guide the editors of POPULAR SCIENCE MONTHLY today. The magazine he founded has become the standard bearer of American enterprise and progress. And as our audience has grown from the few hundred of 1872 to more than a million, our task has increased proportionately. It is fourfold:

To report the news of laboratories and workshops, and interpret its meaning in a way that everyone can understand.

To help people use products of science for their greatest value.

To make the achievements of science not only understandable, but interesting to busy men.

Finally, to help people see, in wonders of the present, visions of future goals to be attained.

POPULAR SCIENCE MONTHLY devotes itself, not to those "who have eyes but see not," but to those who, even though blind, can see the vision of progress.

The Path of Good Business

THE discovery of a way to draw out tungsten metal into fine filament wire revolutionized the electric lighting industry. Chemical creation of rayon changed the silk trade almost overnight. The automobile turned gasoline, once a drug on the market, into a business of fabulous wealth.

In Germany, virtually every banking house now employs a staff of technical experts—scientific advisers and prophets who supply prompt information about discoveries vital to industry. From the great English economist, Sir Alfred Mond, comes the warning that, neither in the United States nor Great Britain, are financial leaders keeping pace in this respect.

American banks should have diligent respect for the dictates of science. Yankee ingenuity made this nation what it is. Ahead is the unknown. The research laboratory is the pathfinder. Only by watching scientific progress closely can industry be assured of safety and prosperity.

Who Wants Airplanes?

IN 1850, a young man returned home for a vacation. He told his friends that he worked in a factory which made seven complete watches a day. They charged him with falsehood, saying, "Why, where could they *sell* seven watches a day?"

In 1900, Henry Ford's father told him he ought to get into something with a future, instead of the automobile business. A few hundred cars, he said, would supply the demand for automobiles in this country. But Henry Ford had vision. That vision broke the chains that bound people to their dooryards.

In 1928, a speaker declared that the demand for airplanes always will be limited, because only a few can learn to run them. But young people, now building models such as that described on page 56 while they wait until they are old enough to fly, will take care of the demand.

Beating Nature's Patents

EFFORTS of postal employees to invent a machine to tie packages failed as long as they attempted to imitate the workings of the human hand. Another inventor built a flying machine fashioned carefully after the body of a sea gull. In a trial flight the machine failed, killing its designer.

Mechanically, man is rarely successful in imitating Nature, but he can improve on Nature. To prove this for yourself, you need only turn to page 18. Airplanes, looking totally unlike birds, can fly much faster than the fastest bird.

When Do You Go Fishing?

TWO friends, Jim and Joe, go fishing together. They catch nothing. Another day they have great luck. Jim remembers that on the day he caught the fish, he wore a red tie. So now, whenever he goes fishing, he wears that same tie to make the fish bite! Joe recalls that the first day was blistering hot, while the second was overcast, with rain threatening. Now he goes angling on overcast days. Jim is superstitious; Joe scientific. It is remembering the right thing that makes a scientist.

The pages in Frazer's "The Golden Bough" are packed with examples of primitive, superstitious peoples who have remembered the wrong thing. The life of Noguchi, great conqueror of disease, whose heroic death is reported in this issue, was filled with incidents in which he remembered the right thing, knew the relation between cause and effect. That difference represents the fruit of centuries of mental growth. The human brain, like a piece of real estate, increases in value directly with the number of worthwhile inhabitants.

If Electrons Were Dewdrops

A DROP of dew on the tip of a blade of grass. Watch it closely. It begins to swell! It breaks into two drops. The two drops break into four, the four into eight, and so on. They run down the stalk. They form a pool at the bottom. The pool grows into a pond; the pond spreads into a lake. The drops multiply until they cover a state, until they inundate a nation, and finally the whole earth.

A nightmare? No. Only what would happen if the electrons in a single drop of water expanded until each became the size of the original drop. Fortunately, Nature has laws that hold each thing to its proper size.

When Playthings Pay

PEPPER stung the mouth of a Dutch janitor, the discovery of microbes followed.

Leeuwenhoek, first to see a microbe, thought the pepper that stung his tongue must have sharp points. So he looked at the particles through a microscope. From pepper, he went to other things, until he opened a whole new field of science. His microscope started as a plaything, ended important to all men.

Plaything first, practical benefit to man afterwards. Those are the two steps most great inventions have taken. Read the article on page 31 of this issue. Remember that at first Roentgen had no practical use for his mysterious X-rays.

C & L 158

This blow-torch is especially made and priced for the man who likes to do odd jobs around the house, or to tinker with mechanical things. It will last a lifetime if it is not abused. The usual retail price is about five dollars. Most hardware, electrical and automobile accessory stores have it—or can get it for you quickly.
Look for the red handle

Whatever you need in a blow-torch you'll find in the Clayton & Lambert line

PERHAPS you use a blow-torch only once in a while. In that case you don't need a torch built for hard use on every kind of a job, every day and all day. And you don't need to pay the higher price, either. Not when you can buy the new Clayton & Lambert 158.

It's a low-priced blow-torch—just what you want—but we don't know where you can buy a better blow-torch at any price, outside of the Clayton & Lambert line. It's husky, with a strong, thick base that protects the tank. Everything in it is made to exacting precision standards, so that it works right—and keeps on working right as long as it is not abused. It holds its compression. And it gives you a hot flame in a jiffy.

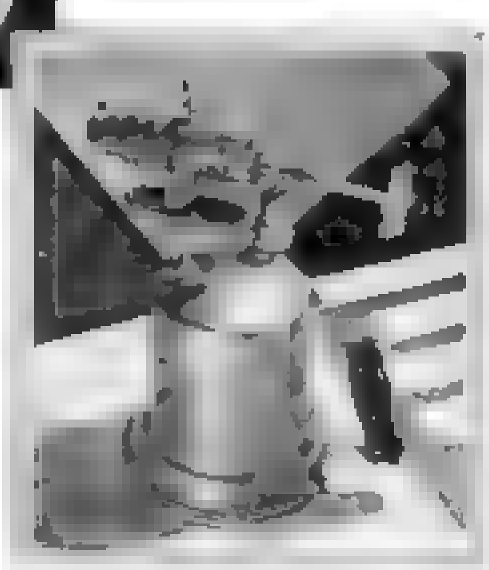
On the other hand, if you do use a blow-torch in your daily work, we believe you'll find the Clayton & Lambert 32 better suited to your needs. For in addition to the excellent qualities of the 158, it has the new, patented, Clayton & Lambert gas orifice. That orifice is made to the exact size for perfect operation. And it cannot be spread and enlarged by the needle-valve. Nor can it clog; every time you turn the torch off, the needle-valve cleans the orifice.

There are other refinements, too, which make a difference in performance and length of life. The difference is so notable that blow-torch users have made the Clayton & Lambert line the most popular in the world.

Hardware, electrical and supply houses sell these Clayton & Lambert blow-torches—or if they don't have them in stock will get them for you quickly. You can tell them quickly because they've got *red handles.*

PROTECTION
C&L
MFG CO

CLAYTON & LAMBERT MANUFACTURING CO.
DETROIT, MICHIGAN



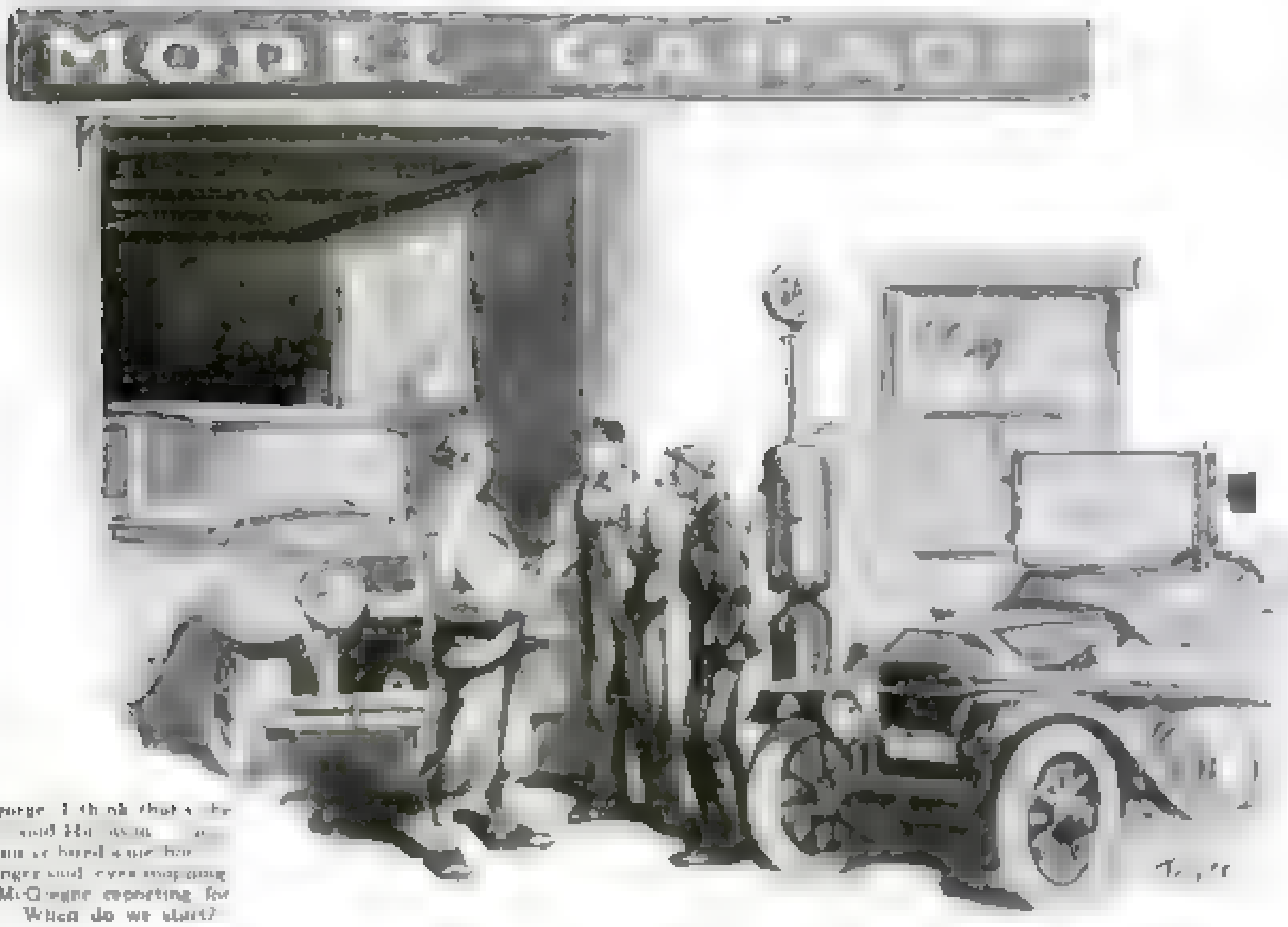
C & L 32

This is one of the most popular blow-torches we have ever made. It is more expensive than the 158 because it is made for much harder use. It is designed for the man who uses a blow-torch in his daily business and demands not only excellent performance but rugged ability to stand rough handling. 32 contains the most advanced, patented C & L blow-torch improvements. It also has a red handle.

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Spare Parts *You Should* Carry

Gus Tells What Will Get You Out of Trouble On the Road and What Will Just Burden You



"By George, I think that's the answer," said Harbison. "...ernor you've hired a new hand." the stranger said, eyes snapping. "Alec McQuggie reporting for service. When do we start?"

By
MARTIN BUNN

"NUTS," observed Joe Clark as he came out of the office with a letter in his hand, "are the life of the auto business."

Gus Wilson, his partner in the Model Garage, poked his head out from under the car he was repairing.

"What kind?" he grumbled. "The ones that hold the cars together or the ones that ride in 'em?"

"The ones that ride, of course," laughed Joe. "Here's a letter from the worst auto nut in this section. Can you guess who?"

"Easy!" Gus grunted. "That'll be Samuel P. Harbison—old 'Spare Parts' Harbison! What's eating him now?"

"He's going on a long tour," Joe began, "and—"

"Don't tell me any more," interrupted Gus. "I can guess the rest, too. He's worked up a list of spare parts as long as your arm and wants to drop in and waste my time arguing about what else to take."

And Gus was right, for in a few minutes Harbison appeared. His list was not so long as Gus had predicted, but it was long enough, and Gus thoughtfully nodded his head in approval as he checked over the first few items.

"'Spark plugs, sizzle patches, blow-out shoes, friction tape, insulated wire, headlight bulbs, tail-light bulbs,'" Gus paused. "Those ought to be in the tool box of every car that goes touring," he observed. "Now let's see what else you are going to take. 'Spark coil with condenser'—there's a spare part nobody carries, and yet when either the condenser or coil goes bad, there you stay until you get a new part or go home on the end of a tow line.

"'Fan belt, extra piston, piston rings, can of water, can of oil, can of gas,'" Gus read. "Holy jumping spark plugs!" he gasped. "Where on earth are you going—across the Sahara Desert?"

"Not quite that far, Gus," replied Harbison a trifle sheepishly. "Only up around New England and then out to Buffalo by way of Albany and Schenectady."

"YOU couldn't get more than a few miles from a gasoline station on that route if you tried," snorted Gus. "I guess, Mr. Harbison, you're off on the wrong foot. There's no sense trying to carry a spare for every part that might break. You might just as well tow a spare car."

"But I hate to take a chance," protested Harbison.

"Every time you climb into your car you take a chance anyway," scoffed Gus. "And besides, what good would parts like a connecting rod and timing chain do you? If they break while the motor is running there's going to be a lot of other damage. Very likely the crank case and the piston will get smashed if the connecting rod lets go, and the timing chain case plus a couple of sprockets usually are ruined when the timing chain parts company.

"What you ought to do," continued Gus, pausing to glance at an ancient car that had drawn up in front of the garage, "is to forget about the breakdowns that might happen once in a million times and concentrate on the troubles that happen a lot oftener, particularly the ones that there's no way of fixing up enough to get to the nearest service station."

"Sounds logical enough to you, Gus," sighed Harbison. "I must be a queer case. I'm keen on keeping the car in perfect mechanical condition and I haven't the mechanical ability to do it. I know the theory of the thing, but my fingers are all thumbs. I can't even change a spark plug without barking my knuckles."

While Harbison had been talking the owner of the ancient bus had quietly strolled over.

"Howdy folks!" he began. "Any chance for a real good auto mechanic to pick up a few dollars around here?"

"That depends— (Continued on page 111)

Helpful Kinks *for* Your Car

Opening Garage Doors Without Leaving Car—Simple Tester For Valves—Handy Trouble Light—Single Contact Bulb

WHEN you come back from a drive it is a nuisance to have to get out, unlock and open the garage doors, climb back in the car, and drive in. A novel and ingenious way to arrange self-opening garage doors is shown in Fig. 1, and details of construction are given in Fig. 2. Instead of stopping the car you reach out and pull the end of cord placed conveniently near the driveway and some distance from the garage doors. The doors at once swing open and you continue into the garage.

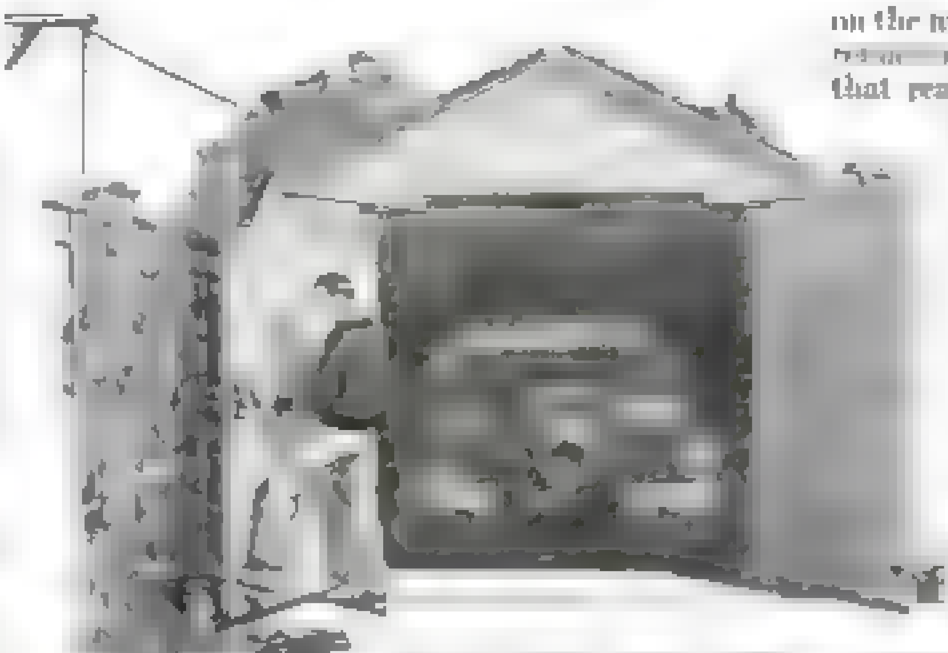


Fig. 1. Closing garage doors after getting in, by pulling cord to operate the weights and driving in without leaving car.

The secret lies in the peculiar leverage that translates the downward pull of two weights into effective opening pulls on the doors. Note that the point of attachment for the end of the cord is on the end of wooden frame so that as the door swings outward the point of attachment moves to let the weight go downward. Fig. 2 shows the release latch which should, of course, be fitted to the door which has a bead to keep the other door closed.

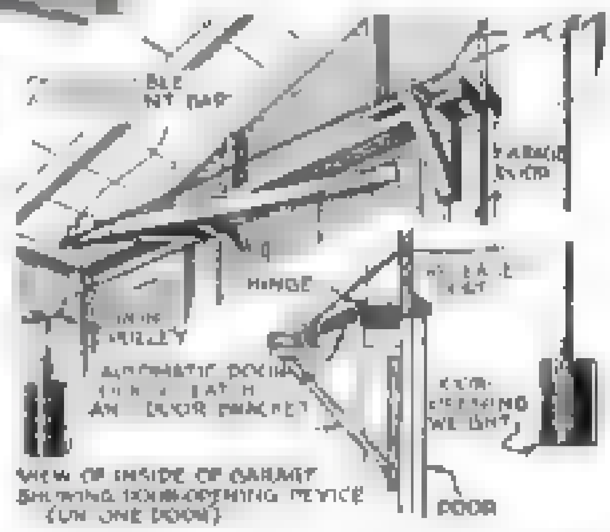


Fig. 2. Arrangement of weights and pulleys to open garage doors and the release latch which is used to put the handy device in operation.

Ten Dollars for an Idea!

WALTER E. BAILEY, of Maywood, California, wins this month's $10 prize with his suggestion for garage doors opened without leaving the car (Figs. 1 and 2). Each month Popular Science Monthly awards $10, in addition to regular space rates, for the best idea sent in for motorists. Other contributions published are paid for at usual rates.

Handy Trouble Light

THE best place for a trouble light is where it will shed its rays on the work as nearly as possible in line with the line of sight. When working around a car you constantly shift your point of view, so no matter where you fasten the light there are often shadows just where you want to see what you are doing. Fig. 3 shows how to fix up a trouble light that will always be where you want it. A cork takes the place of the regular reflector and lens, with a screw in the center of the cork to make contact with the center electrode of the battery. A Christmas tree lamp socket or a standard miniature lamp socket is connected to a length of electric light drop cord with one of the wires connected to the screw in the cork and the other to the case by jamming it under the lens retainer ring threads. The socket is attached to the brim of your hat by means of a wire bent as shown in the illustration.

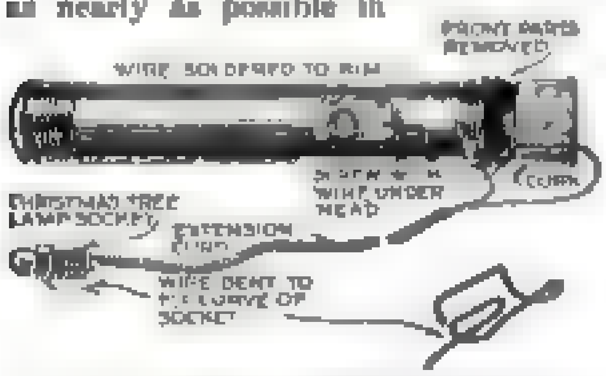


Fig. 3. Design for a trouble light for attachment to your hat brim so that it shines always directly on work anywhere about your car.

Improvised Bulb of Single Contact

SOMETIMES it is impossible to obtain in an emergency a single-contact auto bulb of the candlepower you desire. However, if you can obtain a double-contact bulb of the required candlepower a minute's work with a soldering iron will convert it for single contact use. Remove the gob of solder on one of the contacts and flow it down over the insulation so that the solder makes a firm contact on the metal shell. Then add solder to the remaining contact in the form of a gob that reaches over toward, without quite touching, the other contact. The changes are illustrated in Fig. 4, at bottom of the page.

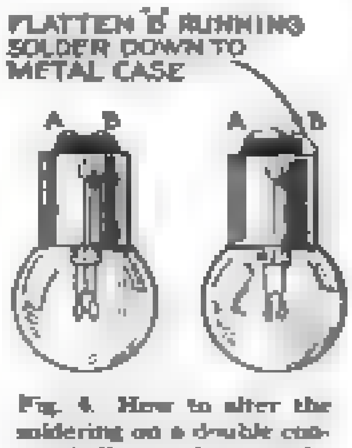


Fig. 4. How to alter the soldering on a double contact bulb to make it single.

Tin Can Valve Tester

IT IS not necessary to do very much grinding to make an auto valve gas-tight unless the valve is badly warped or pitted. In fact, too much grinding makes the seat too wide. It is, however, difficult to tell when the valve is actually gas-tight. Fig. 5 shows a simple way to make a valve tester that will tell at once if the valve is gas-tight.

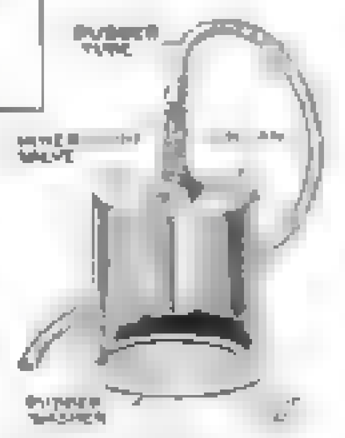


Fig. 5. Place this device over the valve and if you can blow into it continuously the valve tested is not gas-tight.

Through the bottom of a tin can drill a hole large enough to let the stem of a tire valve pass through. Use washers cut from an old inner tube to make the valve stem an air-tight fit and also cut a large rubber washer that can be placed under the edge of the can as shown in the illustration. A short section of rubber tubing slipped over the end of the valve stem completes the equipment. To test a valve, wipe both the face and seat so that they will be free from oil or grinding paste, press the can tightly over the valve with the rubber washer under it, and blow in the tube. If you can continue blowing it proves that air is leaking past the valve and further grinding is needed. Make sure the tester is air-tight by testing it on a flat metal surface. The piston top will serve as a test surface.


Tycos
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How to Enamel a Front Door

A Well-Finished Entrance Reflects Credit on a House and Spells "Welcome"—Hints for the Amateur by *F. N. Vanderwalker*

Fig. 1. For the finest effect, the enamel is rubbed smooth with pumice stone and water

ALTHOUGH we expect much of the front doors of our homes, we pay scant attention to them once they have been selected to give the right atmosphere and architectural detail. There is, however, something else besides the character and design of the front door that conveys to guests their first impression of the home, and that is its state of preservation.

Too many fine doors with outside exposure have come to be a source of annoyance because the finish has crumbled away, faded or blistered in the sun, or because they have warped badly or even show signs of falling apart on their hinges.

For the exacting service of finishing doors it must be remembered that only the finest paint, enamel, varnish, or lacquer should be used. Furthermore, every inch of the door must be protected, not merely the front and back faces and the lock edge. Even painters, in their rush to finish a job taken on a price basis, often fail to coat the top and bottom edges of doors to seal the surface against moisture. And what is the use of sealing the front and back if we leave the top and bottom edges to draw up water like a sponge?

Some doors, particularly those of the flush panel type, consist of a soft wood core of many small pieces glued together and veneer glued on the exposed surfaces. Even if waterproof glue has been used in the construction of a door of this kind, it will be affected by moisture unless well protected with a waterproof finish, and if ordinary glue has been used, it has about as much chance to hold together in the presence of moisture as a Japanese lantern.

Fig. 2. No visitor can help noticing whether or not the front entrance is well painted.

Doors made of planks or of solid wood stiles with solid panels will withstand water reasonably well, but they are likely to warp as much as ½ or ¾ in. out of line unless well protected. Doors are made from very dry wood, and it is well known that unless they are given a coating of some protective material the minute they arrive at a new building they are likely to absorb enough moisture, if only from the damp air, to cause them to warp.

This article will describe in detail the application of enamels of the varnish-base type (not brushing lacquers). Other finishes will be described in future articles.

Be sure to choose an enamel made specifically for exterior wear. It will cost from \$5 to \$8 a gallon, but you will need only about one quart for a door. Exterior enamel usually comes in white alone, but sometimes it can be obtained in light tints. White enamel can be tinted by adding to it a little of the desired color ground in japan—that is, in varnish. If only a small amount of color is needed for a very light tint, it is possible to use the more common and easily obtained tinting colors ground in oil. In either case, thin a little of the color with turpentine and break up the lumps, if any, then strain it through cheesecloth before adding it to the white enamel.

Before the enamel is applied, however, a new door should have at least two coats of enamel undercoater. This also must be of a type made for exterior use. An enamel undercoater for interior wear may turn gray or black when exposed outside. In place of a prepared undercoater, you can use a coat of white lead thinned with a mixture of three parts turpentine and one part boiled linseed oil.

An old door that has been varnished should first be sandpapered well with No. 1 paper to cut the gloss. If the old varnish is simply dull or shows fine hair-line cracks, there is no need to remove it. If, however, it is scaling off, sandpaper hard enough to take off all the varnish. Unless it comes off easily, use a liquid varnish remover, which will hasten the work.

IF YOU have to finish an old door from which all the varnish has been removed, use as a first coat the enamel undercoater as it comes from the can. If some of the varnish remains, however, the first coat of enamel undercoater should have a few ounces of the enamel added to it to make it take a firmer hold on the old surface. For the second coat, use the straight undercoater.

One of the best brushes for applying both the undercoats and the enamel is a 2- or 2½-in. flat varnish brush, as shown in Fig. 3. You must have a good one, which will cost between 50 and 75 cents.

A convenient procedure is to remove the door and stand it on the front or back edge. Paint the top and bottom edges, hang the door again, and paint the front and back edges. Then paint the front and back faces. In the case of a four- or six- or eight-panel door, as in Fig. 2, it is well to paint the (Continued on page 101)

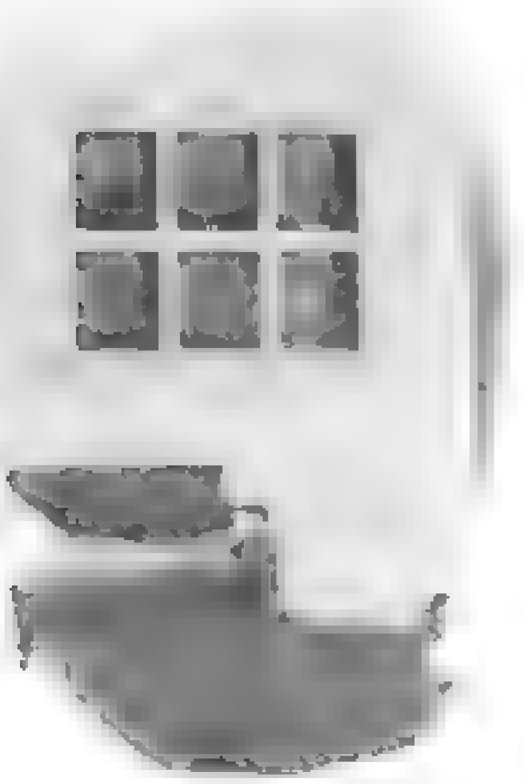
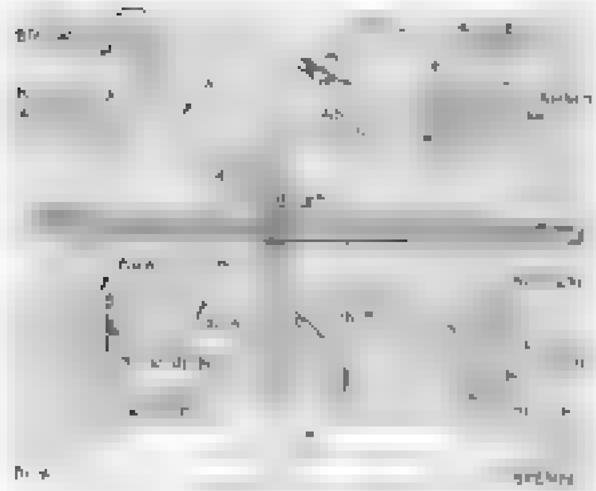


Fig. 3. Mr. Vanderwalker, an authority on painting, shows how to apply the first coat on a front door.

Jack Hazzard, Racing Canoeist, Gives a Few

Useful Hints *for* Outdoor Men

Showing How to Make a Fast Motor Boat from an Old Canoe, an Oven from a Lard Can, and a Weather Vane from Scraps



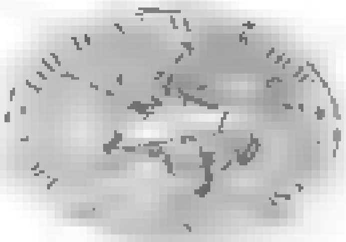


Fig. 1 (at left). Side and top views of the canoe and details of pivot and paddles.

Fig. 2 (at right). A weather vane for clubhouse or camp.

ALL hands had been looking for Bill Norton for two or three days. Not that Bill was particularly sought after; but when a canoeist goes for a week's jaunt by himself and is days overdue, there is a great wagging of wise heads, and the rocking-chair fleet at the clubhouse hang out the black crape. In this instance they might have saved the trouble, for one evening a black speck far up the river—it had the spreading white whiskers of a motor craft—grew to discernible proportions and disclosed Bill nursing an outboard motor attached to what was left of his paddling canoe (Fig. 4).

The rocking-chair fleet fell into cruising formation and overhauled Bill in the locker room.

"My canoe?" said Bill. "Why, I straddled a sharp rock in Tail Race Chute. The end of the old boat was so badly stove that I left the wreck in a fisherman's hut and was about to take the train home when the old chap asked why I didn't put in a bulkhead. With some of his tools, I cut the damaged end off square, turned back the canvas, and fitted and screwed a piece of hardwood plank inside the hull (Fig. 3). Then I scraped off what was left of the old paint, varnish, and filler from the loose canvas, spread half a can of hot canoe glue over the bulkhead, and tacked the canvas to it, cutting away where necessary to make it lie flat. Another coat of glue made the job water-tight.

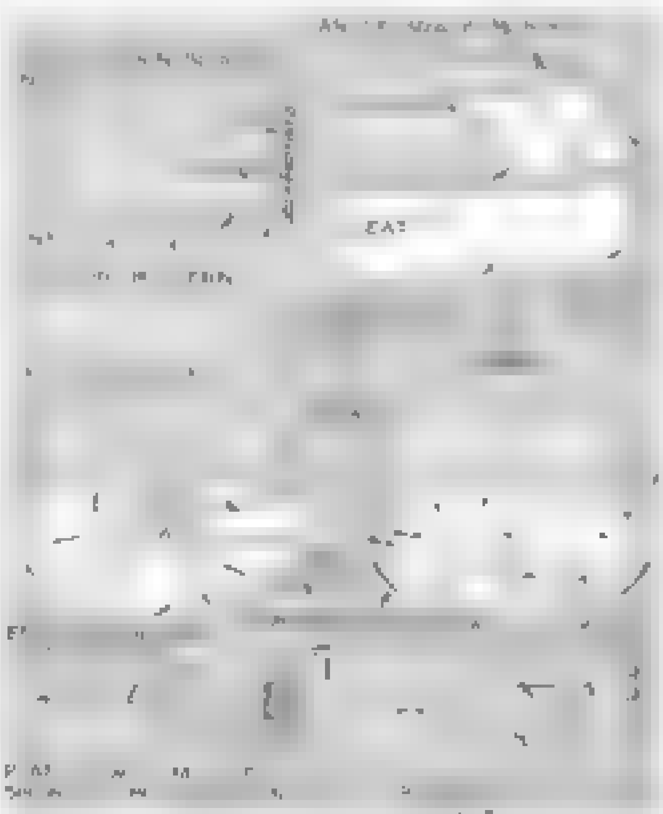


Fig. 3. How an old canoe, even if one end is badly damaged, can be fitted with a square stern. The method of construction requires but few tools and no more than ordinary toolcraft.

"I sawed out another hardwood bulkhead similar to the first, but large enough to cover the ends of the planking and wales. This I screwed to its mate, having first applied a liberal coat of hot canoe glue. To stiffen the bulkhead still further, I cut and placed a hardwood knee on each side of the stern at the juncture of the bulkhead and wales, and to stiffen the bottom and distribute the thrust of the motor, I screwed three oak battens to the ribs. On these went three heavy knees, screwed to the battens and ribs and bolted to the bulkhead. Rigging the stern seat and putting in a new heavy keel took more elbow grease than brains. Anyhow, here I am."

Later, to the already usable keel, Bill screwed a rocker-shaped oak keel, 3 in. deep at the center, and fitted a mast step well up in the bow. Then, with sixty square feet of sail, he found he had a sporty sailing craft which would step with the best of them.

Fig. 4. Square stern canoes are popular for use with outboard motors, but also make sturdy, fast, sailing craft.

BESS sighed and let a cascade of glistening blackberries slip through bronzed fingers.

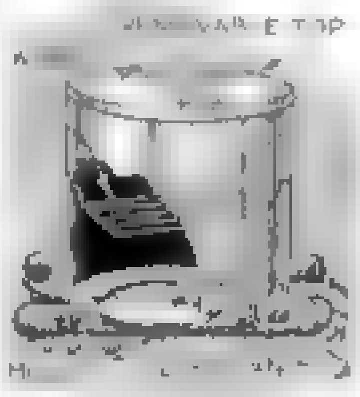


Fig. 5. An oven in which even pies can be baked.

"If I only had the oven I'd make pie."

"Pie? Oven?" Jim uncoiled his long legs and rolled out of the hammock with alacrity. Two weeks of shifting camp, with baking limited to camp biscuits and flapjacks, had sharpened his imagination.

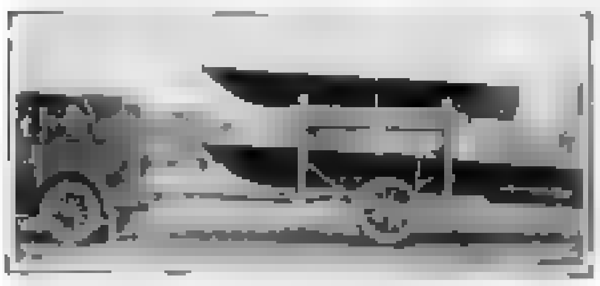
With the can opener he roughly cut a circular opening in the bottom of a large lard can (Fig. 5), in which had been packed the more spillable grub. In the sides he punched four holes midway between top and (Continued on page 99)

Homemade Trailer for Boats

By Newcomb Leonarde

THE trailer illustrated is well adapted for transporting outboard motor boats and other camp equipment. It is constructed on a Ford Model-T front axle, which may be purchased for a few dollars from any automobile junk dealer.

The two steering knuckle arms are bent around until they are in contact with the axle itself and then bolted to it; this keeps the wheels from turning independently. New underslung spring pads made of flat iron are bolted to the old spring seats, and a double platform spring, made up of an assembly of discarded Ford springs, is



This double-deck trailer for small boats is mounted on a discarded Ford front axle.

then fastened to these spring pads with the usual Ford parts. A Ford V-type radius rod is bolted to the spring hangers and carried forward and bolted by means of a U-bolt to the tongue or backbone of the trailer.

The framework is made entirely of wood, either oak or long-leaf yellow pine, and braced with flat iron. The tongue of the trailer is equipped with a universal joint—it may be homemade or purchased from one of the trailer builders—so as to allow the trailer to track with the towing car.

The outfit pictured was also furnished with a roller on the rear end of each deck so that the boats can be taken off or put on by one man. These were mounted on eccentric cams and when folded down are not in contact with the boat's bottom. A tail-light extension wire is carried back to the rear of the larger boat.

Puller for Fence Staples

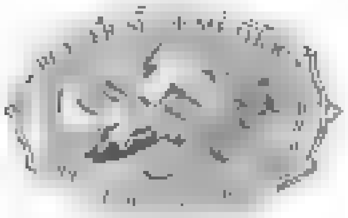
HERE is another tool for pulling obstinate staples when fencing. It gets them all, indeed, it is better than an expensive pair of fencing pliers that I have. I made the puller from ⅜ in. square steel and hardened it.—H. H.

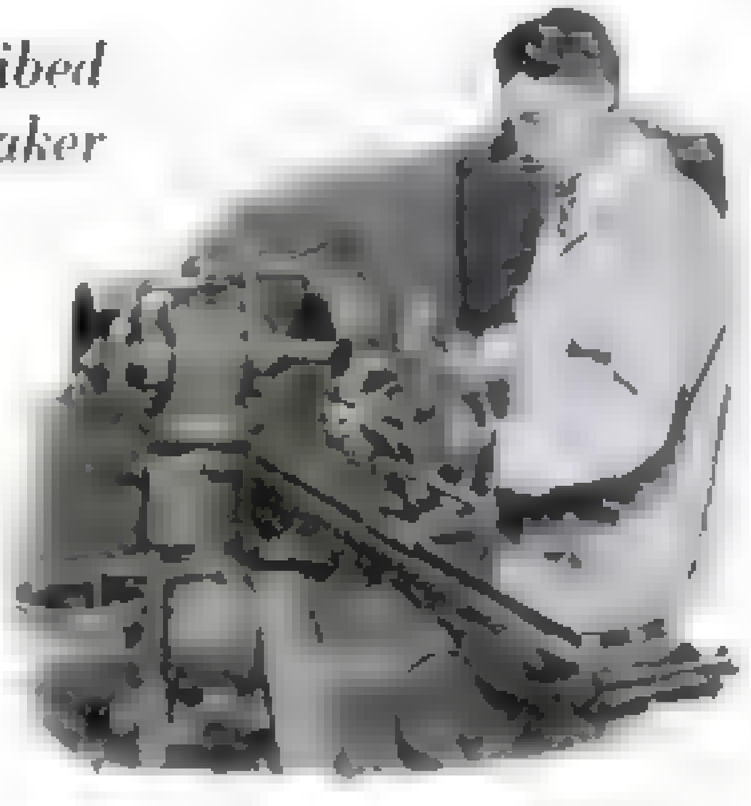
How the tool is used to withdraw staples.

IN MAKING saw cuts across the grain of a board for the purpose of forming a groove or dado, the beginner in woodworking may have trouble in following the lines accurately. A short straightedge, bradded or held with a hand screw against the outer side of the knife mark, will guide the saw.—C. K.

Simplified Cutter Grinding

Practical Methods for Small Shops Described by Hector J. Chamberland, *Expert Toolmaker*





Grinding a formed cutter. The efficiency of a cutter depends largely upon the grinding.

LARGE manufacturing plants that use many milling cutters and similar tools usually make a certain amount of their tool equipment, not as a matter of economy—for the cost generally runs higher than if the tools were ordered outside—but because the work helps to keep the tool room or machine shop on a regular working schedule and, in case of a rush job, makes it possible to supply special needs almost immediately. For these reasons a full grinding department is maintained, and to a certain extent the various grinding operations are carried out on a production basis.

On the other hand, the small shop in which a cutter is seldom made has to be content with a universal tool or cutter grinder to do the work. Let us consider a shop with six milling machines: The working force would probably average from eighteen to twenty-four men. The tool crib is likely to be without an attendant. This is poor policy financially, although it is to be admitted that a man cannot be kept busy handing out tools. If the cutter grinder were in the crib, the attendant could master the grinding of mills very quickly, and with little interference to his regular work he could give them attention. Production obviously would benefit.

Cutters are often used when in reality they are not fit for a milling job. To grind .010 in. from a tool at eight different times is better business than to remove .080 in. at one time. Considering the fact that probably 80 percent of milling cutters today are of high-speed steel, great care should be exercised in keeping them always in first-class condition. Manufacturers spare nothing in producing high-grade tools, but many times through poor grinding the life of the tools is cut more than half, and the maker generally gets his share of criticism without any reason whatsoever.

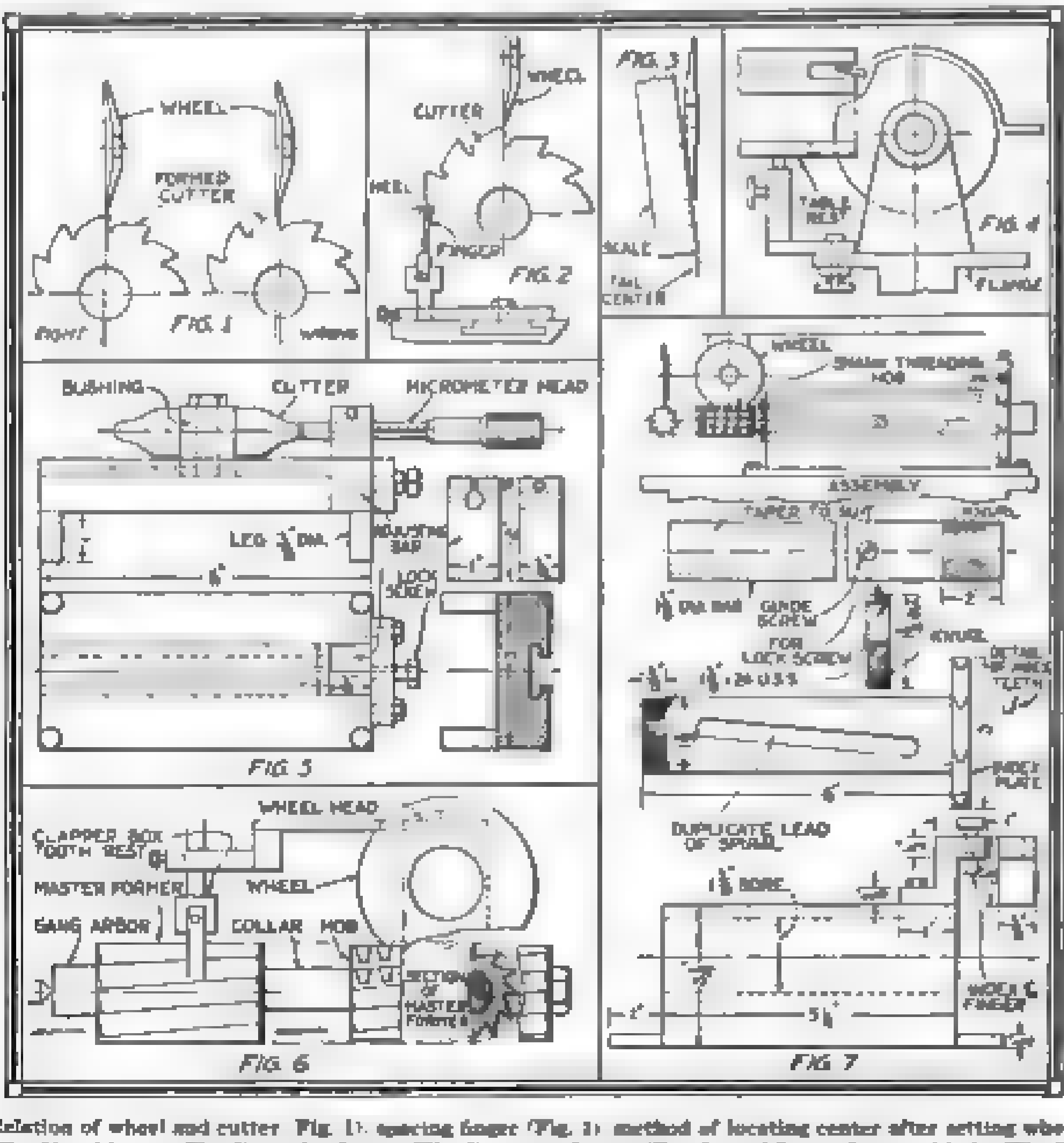
Milling cutters are made in two different types, and grinding the teeth presents two entirely separate problems.

Formed cutters are sharpened on the face of the teeth, and their forms are never disturbed. In order to reproduce their exact profile on a piece of work, the teeth must be radial; if they are not, trouble is sure to follow. A safe and accurate method for doing this work without regular equipment which is costly was described and illustrated in the November, 1927, issue of POPULAR SCIENCE MONTHLY, page 118. By that method the diamond-truing arrangement keeps the teeth radial.

WHERE no diamond is used, the same procedure may be followed by feeding the wheel downward instead of toward the face (see Fig. 1), once the center line has been located in relation to the wheel and the cutter has been rotated an amount equal to the stock to be removed. The cross feed never should be changed, as the grinding is done from the top of the tooth down. This method keeps the teeth radial and equidistant.

Another scheme practiced where no indexing centers are at hand is to use a spacing finger on the heel of the teeth. In this case, as in Fig. 2, a collar arbor is "dogged" between centers and the nut is loosened for indexing. It is good practice to apply the finger to the heel of the tooth being ground. Large cutters can be tested on centers for equidistance and any high teeth reground.

Small gear cutters, tap cutters, and reamer cutters may be sharpened by hand with the use of a small table rest, which is clamped to the flange of the wheel head as in Fig. 4. Note that the cutter and the wheel must be relatively radial with each (Continued on page 86)



Relation of wheel and cutter (Fig. 1), spacing finger (Fig. 2), method of locating center after setting wheel (Fig. 3), table rest (Fig. 4), testing fixture (Fig. 5), master former (Fig. 6), and fixture for spiral hobs (Fig. 7).

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

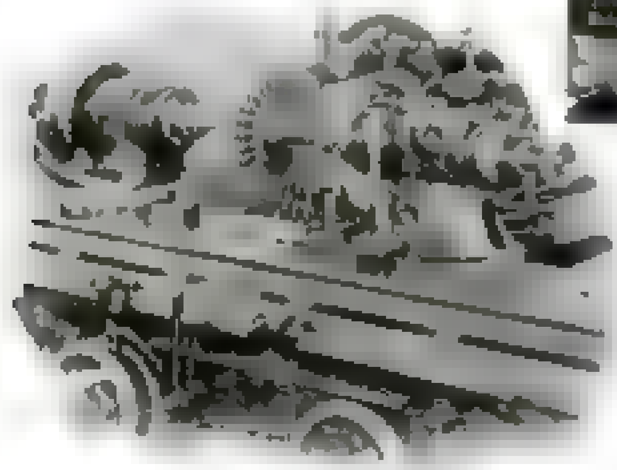
other or the teeth will not be ground square.

The fixture illustrated in Fig. 5 is used to test the cutters on the periphery, it can be made at small cost and will prove handy for other such jobs. The micrometer reading will show if the teeth are of uniform distance from the center line. Each tooth is ground individually until the cutter runs true.

It may be that a small shop has a number of spiral hobs used in cutting some special gear or thread. The true angle of the spiral on these must be maintained. This can be accomplished only by the use of a special fixture, such as the one illustrated in Fig. 7. It will take hobs of spiral design up to 3 in. in diameter and 3½ in. long. The grinding is done with the convex side of the wheel, as this allows for clearance as the cutter rotates and follows its original lead. The wheel thus grinds from its radial or high section only.

The set-up is the same as in milling the teeth; that is, the fixture is set at the same angle as the spiral, which is always marked on the cutters, and the center located as shown in Fig. 3. The face of the tooth is then brought against the cutting side of the wheel and the cutter is loosened up, revolved from .003 to .005 in., and tightened. The set-up is now ready for grinding. The cylindrical bar is worked back and forth after each index, and if the cutter is not sharp it is rotated the same amount again. The cross feed never should be disturbed and the wheel should be dressed only when starting each piece.

Another method which is quite accurate and cheaper than the above is to make a master former with the same lead as the hob as in Fig. 6.



A side milling cutter set up for sharpening on a standard universal grinding machine

The two are lined up on a gang arbor spaced with a collar. With the aid of a tooth rest bolted on the wheel head, the amount to be removed is regulated by moving the finger or pawl. The operator holds the work with one hand and works the carriage feed with the other. This scheme allows the grinding of larger hobs than the fixture in Fig. 7.

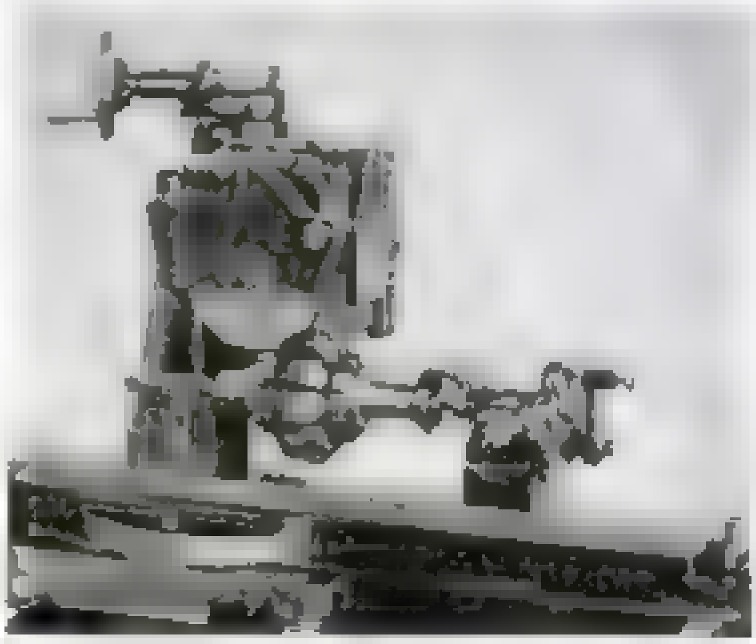
Some gear cutters have staggered teeth. These may be sharpened as illustrated in Fig. 8. A block of hardwood is tapered the same angle as the teeth, and a stud the same size as the hole is fitted in the center. The cutter is placed on the block and the teeth of one angle are ground. Then the cutter is turned over, the grinding wheel reversed, and the teeth of the other angle are ground. The work is done on

Simplified Cutter Grinding

(Continued from page 85)

Hints on Selecting the Right Wheels

Wheels	Grain and Grade	Remarks
Disk	60K	½ in. wide, 6 in. diameter or smaller
Cup	60J	Required diameter
Saucer	60K	For regular formed cutters when feeding downwards
Saucer	60J	For regular formed cutters when feeding against face of the tooth
Saucer	60J	For spiral hobs
Saucer	60I	For threading hobs



To preserve their form, cutters such as this must be sharpened with exactly radial teeth.

the table as in Fig. 4, and the equidistance checked with the fixture shown in Fig. 5.

In Fig. 9 is shown a gage which is indispensable for testing the radial line of formed cutters. It is made of ⅛-in. stock and fitted to any size bushing desired.

After all, it is evident that in sharpening formed cutters two things are essential: The teeth must be radial and equidistant. In case cutters are made with a rake or undercut, it is important that the same rake be retained in sharpening them.

While I prefer to use 60-grain wheels because of the better finish they give, some manufacturers do not recommend anything finer than 46. There is less chance of burning the work with 46-grain wheels.

Another point: Never take chances when grinding. Here are six safety-first hints which always should be observed:

1. Before mounting a new wheel, sound it for cracks by holding it with your finger in the hole and giving the wheel a slight rap with a small wrench.
2. Never force a wheel on a spindle. Scrape the hole if necessary.
3. See that the wheel is well balanced sideways.
4. Use the guard. Even after the wheel is worn down to two thirds its original size, it is best not to omit the guard.
5. Never face any wheel until it has been running at least thirty seconds.

Grinding a hand reamer on another popular type of universal tool grinding machine.

6. Never lay the wheels on the bench; hang them up on a nail or put them away in a safe place.

This is the first of two articles on cutter grinding by Mr. Chamberland, who speaks from many years' experience in the tool rooms of both small and large plants. The second will appear in an early issue. It will give a design for a universal tooth rest with clapper-box mounting and will describe in detail the sharpening of spiral mills and angular cutters.

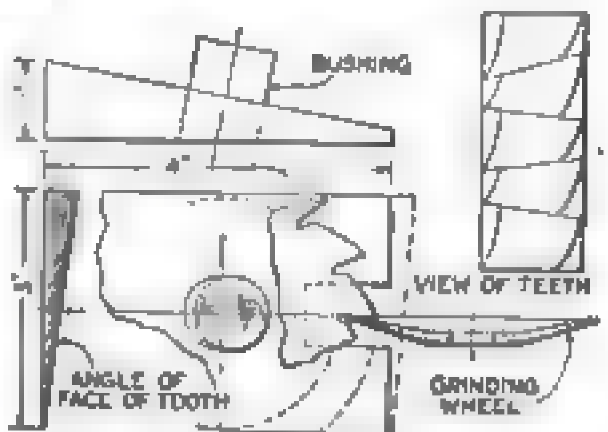


FIG. 8

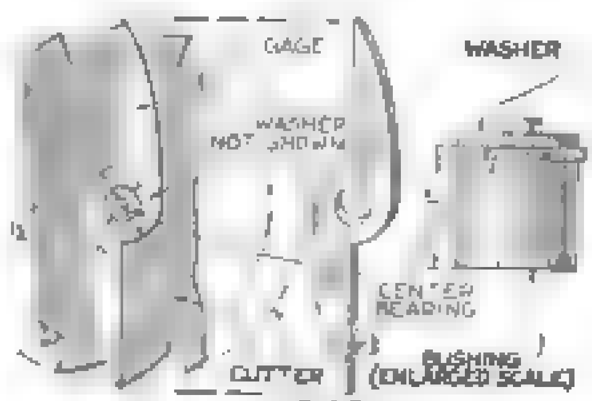
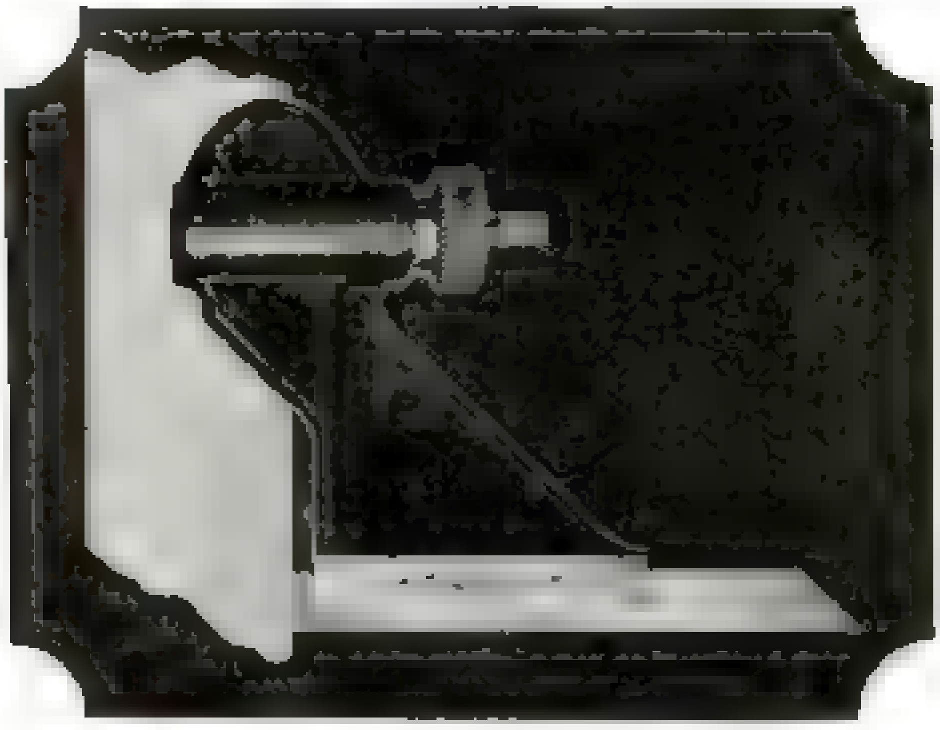


FIG. 9

A method for sharpening staggered tooth cutters, and a radial gage for formed cutters.



The illustration shows the new Brown & Sharpe Height Gauge Attachment for use on Brown & Sharpe Combination Squares and Sets. No. 465A is for 9" blades; No. 465B for 12", 18" or 24" blades.

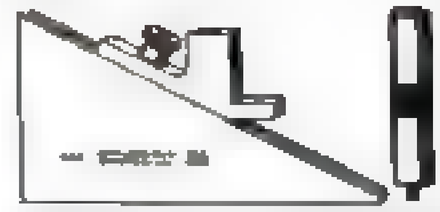
With Attachment No. 465 Your Combination Square Becomes A Useful Height Gauge

You will greatly broaden tne range of usefulness of your Combination Square by using this new Attachment. It will then serve as a handy device for making comparative measurements, finding heights or projections from plane surfaces and for the many other uses of a height gauge.

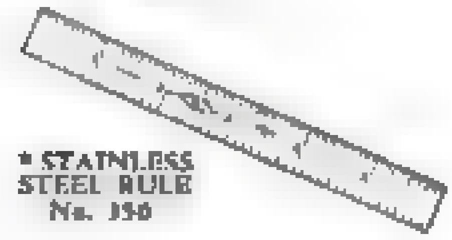
The attachment is reversible and can be used on either side of the blade at all positions from the extreme top to the bottom. Every mechanic, carpenter or home workshop man who owns a Brown & Sharpe Combination Square can have a useful height gauge by purchasing this new attachment.

Your dealer will show you this useful new attachment. Ask him also for a free copy of Catalog No. 30 listing over 5,000 items. If he cannot supply you, write direct to: Dept. P. S., Brown & Sharpe Mfg. Co., Providence, R. I., U. S. A.

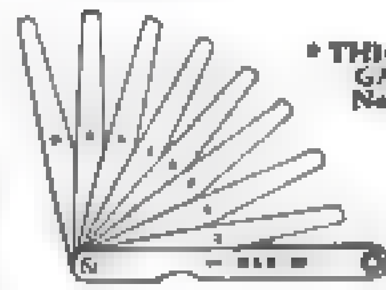
BROWN & SHARPE TOOLS



* PLANER AND SHAPER GAUGE No. 625

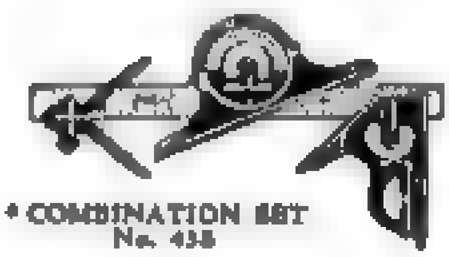


* STAINLESS STEEL RULE No. 350

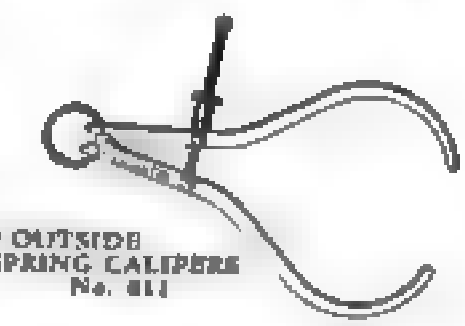


* THICKNESS GAUGE No. 648

* DIE MAKERS' SQUARE No. 552

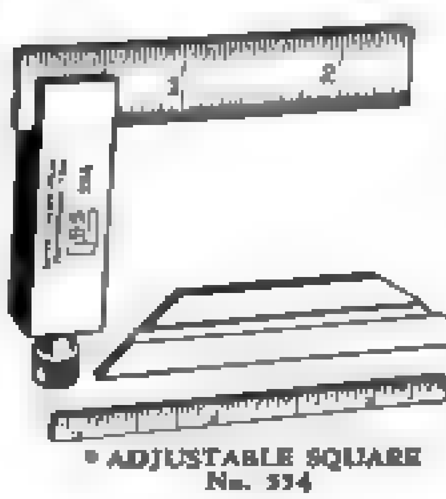


* COMBINATION SET No. 438



* OUTSIDE SPRING CALIPERS No. 811

* SCREW PITCH GAUGE No. 630



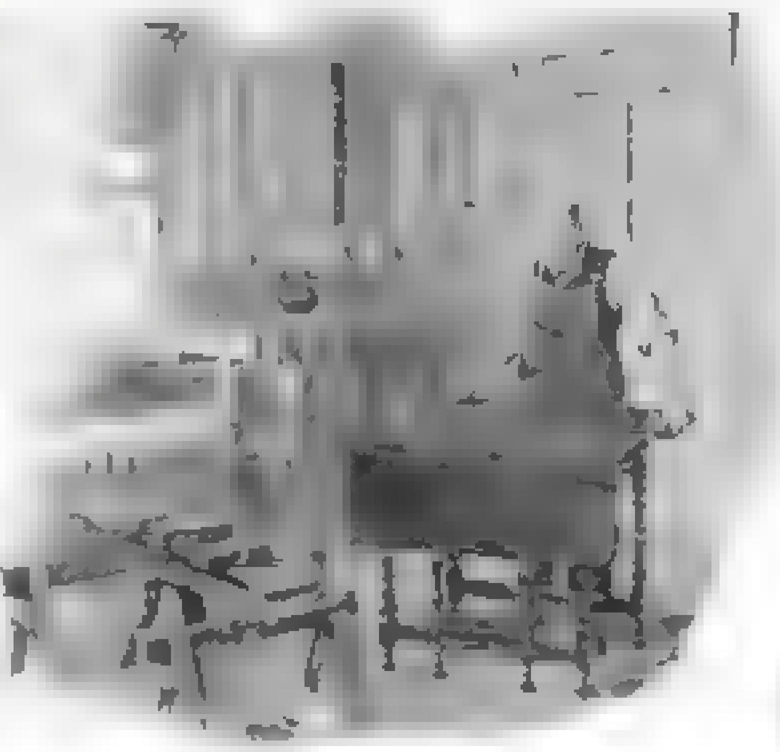
* ADJUSTABLE SQUARE No. 554

* Shown in Catalog No. 30

BS "WORLD'S STANDARD OF ACCURACY"

Don't Chop Up That Old Table

Repairing antique furniture is one of the most interesting and profitable of hobbies. In many attics are pieces well worth saving.



You Can Restore It Even if the Top Is Warped and the Frame Is Falling Apart

By R. C. STANLEY

ANTIQUE drop-leaf and gate-leg tables are so popular and good ones are so hard to get these days, that it pays to do all the patching and repairing necessary in order to save any promising old table. With care and patience one can restore nearly any piece to its original condition.

Let us assume that the table we are working on is a gate-leg table with "rule joints" it has rectangular leaves and three hinges to a side. The hinges were put on with blunt-point screws, which have been rusty for so many years that the wood around them has rotted away and made ugly black spots clear through to the face side. The hinges have broken loose, carrying away a part of the rule joint; the leaves are badly warped; the top has been nailed and renailed to the frame, the frame is loose and "rickety," and nails have been driven through the mortise and tenon joints; half of one leg has been split off and is missing.

Hopeless? Well, it is about ready to be consigned to the basement for kindling wood, but it is an antique and belonged to our great-grandmother. If possible, it must be restored to usefulness.

This is an exaggerated case, but I have been called on to restore just such tables. If you will stay with me, we will make a fairly respectable table out of it. So let's go!

First we must get that warp out of the leaves and top. Take them off the frame, remove the hinges, draw all nails and screws, and remove the old finish, if any, so the wood will absorb moisture. Use whatever facilities you have for getting the boards well soaked with water; if you can steam them, or get them steamed, that is best. Another method is to wet thoroughly a quantity of sawdust or shavings, or a mixture of both, and spread it some two inches deep on the first board. Lay on the second board, cover it similarly, and do the same for the third and any others. Place convenient weights, such as bricks, on the top board and keep the sawdust or shavings wet. It will take several days at least to get the boards well soaked and probably two weeks in cold weather.

MEANWHILE we must prepare a clamp with which to draw the top and leaves straight. One can be made of rough "two-by-fours" and half-inch bolts, with a nut and two washers to each bolt. Bore the wooden pieces in pairs.

Now let's get to work on the frame. Take out all nails. If the frame is pinned with wood pins, back them out with a punch. Splice the broken leg with a piece of wood that matches as well as possible. Make a long, slanting splice. Clean all dirt and glue out of and off the old joints. Reassemble the (Continued on page 89)

Clamps made of rough "two-by-fours" for flattening water-soaked table tops or leaves.

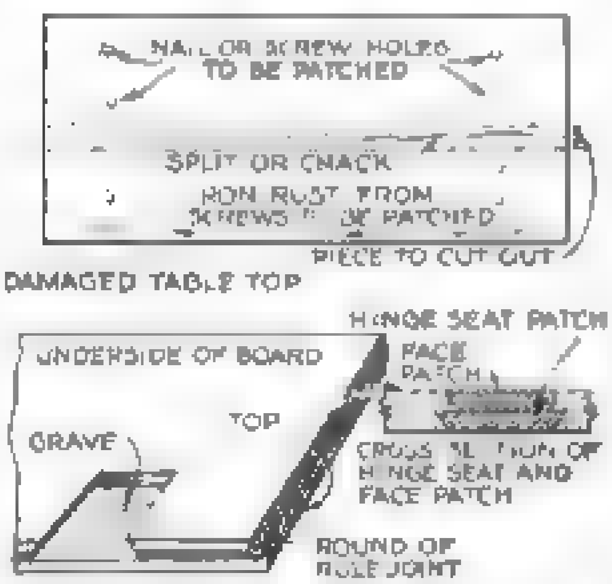
Don't Chop Up That Old Table

(Continued from page 88)

frame with glue in all joints. Insert shims or wedges where necessary to make close fits. After the glue has set, remove the old finish with paint and varnish remover as suggested in the first of these articles, December, 1927, page 86, and apply a coat of boiled linseed oil and turpentine, equal parts. Set the frame aside until the oil is dry.

When satisfied that top and leaves are soaked sufficiently to prevent their splitting when clamped up, put them in the clamps and run all nuts down hand-tight, then start at one corner and go all the way around, giving each nut a couple of turns. Continue until the work is clamped straight. Use enough clamps so that they will not be more than 12 in. apart, center to center. Place the clamped-up work in a warm, dry place.

In drying, the boards will shrink considerably. The clamps exert most of their pressure on the edges, and when the boards shrink, the shrinkage will occur at the point where there is least pressure, or the center of the boards. To prevent this shrinkage from splitting the boards down their centers, it is necessary, in a moderately warm room, to loosen the clamps about twice a day. This allows the boards to shrink naturally. When more than one board is clamped up at a time, narrow



Typical table top defects and an expert's method of patching the old hinge seats.

strips of wood should be placed between the boards at each clamp; the air space allows them to dry more quickly.

When the top and leaves are thoroughly dry, take them from the clamps. They will have flat surfaces once more, but if there are any cracks or splits that cannot be glued up successfully, remove them by ripping out a piece wide enough to include the defects, as above. Joint (plane) the new edges, rip and joint a piece of new material wide enough to replace the part removed, and glue up the boards into the original shape and size. A good clamp for this work was described in the second of these articles, April, 1928, page 97.

Leaves and top are now ready for patching. Patch all nail and screw holes as suggested in the preceding article, July issue, page 96. (Continued on page 115)

How to Do Trick Whittling

By
OLYMPIC JONES

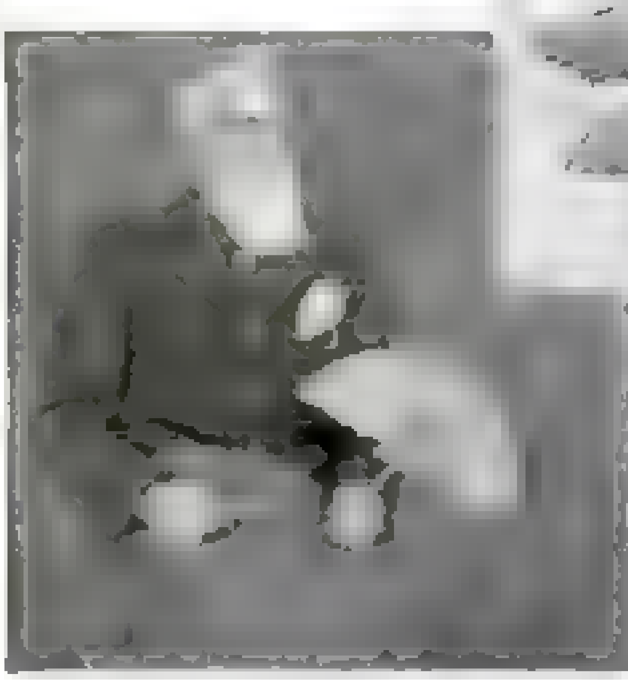


Fig. 1. Whittling fans of lacelike daintiness is the hobby of G. M. Ward, of Retsil, Wash.

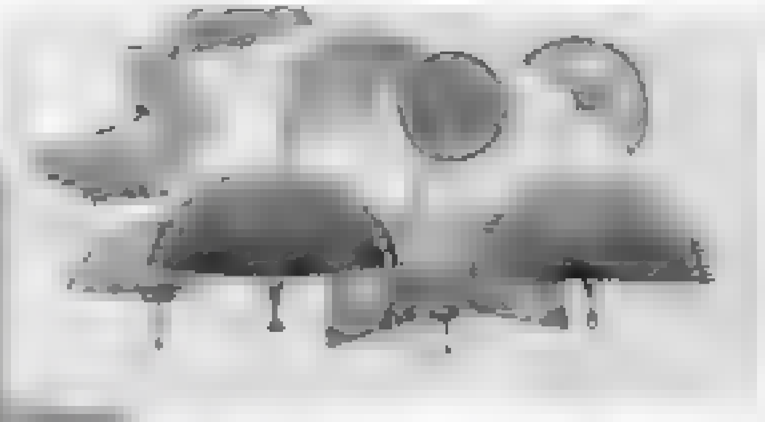


Fig. 2. Examples of Mr. Ward's work to indicate the large variety of possible designs

EVERYONE who has seen ornate and delicate fans whittled from a single piece of wood, like those illustrated in Figs. 1 and 2, has wondered how the work was done. They appear to be the result of almost miraculous skill and patience. As a matter of fact, anyone who is reasonably handy with a pocketknife can make them. The process is really simple, and the size and variety of possible designs are limited only by the imagination of the whittler.

Select a piece of wood with straight, smooth grain, preferably cedar or fir. Split or saw a block from 1/4 to 3/4 in. thick and as long as you wish the fan to be. The width will depend upon how many ribs the fan is to have.

With a knife cut a series of grooves across the width of the block on both sides as shown at A, Fig. 3. These grooves can be varied as desired, they define the shape of the individual ribs when the latter are spread out fanlike. Also shape the handle in any way desired, but leave a strip the width of the block where the handle connects with the cross-section at B, Fig. 3.

Just above this handle block cut the groove C on both sides until the thickness of the wood is from [illegible] to [illegible]. It is here where the twisting is to take place.

When the block has been shaped, boil it in water for thirty minutes. Then split the soft wood down to the handle so as to make as many ribs as possible, but take care to have them all of the same thickness. Spread the ribs apart fan shape, giving them a half twist, and place them under pressure until dry.

Select ribbons to harmonize with the wood and thread them in and out of the openings D, Fig. 3. The number of ribbons used depends upon the way the original grooves in the ribs have been made, as a study of Fig. 2 will make clear.

The fans illustrated are the work of G. M. Ward, of Retsil, Wash.

Fig. 3. After the block has been cut to shape, it is boiled in water for half an hour; then the fan ribs are split apart with a thin knife and twisted.

Snap Fasteners Make Neat Ship Model Deadeyes

SHIP model builders usually find the task of making deadeyes irksome in the extreme, but they can save themselves this work if they are willing to use dress snap fasteners instead. Fasteners of the type illustrated are a good substitute. They can be obtained at any five-and-ten-cent store, notions store, or general mail order house. The sizes range from about [illegible] to [illegible] in. in diameter. I found the 1/4-in. size (marked No. 000) satisfactory on my model of the *Santa Maria*. ALFRED PELLE.

How the fasteners are used on a model.

WHEN fastening the strips of wood called "channels" to the hull of a ship model, a perfect fit can be obtained by placing a piece of fine sandpaper, gritty side out, between the hull and the channel and rubbing the channel back and forth.

Dust Plugs for Chucks and Faceplates

IN SHOPS where lathe chucks and faceplates are kept on the floor when not in use, they collect dirt and grit in the threaded holes. In time the threads become gummed up and screw on the spindle with too much resistance. Operators are sometimes careless about cleaning the threads out, especially if they are hurrying on piece work. Cleaning the threaded holes is a mean job anyway. Consequently, many chucks are permanently damaged and always cause more or less trouble and loss of time.

The plug protects and cleans the threads.

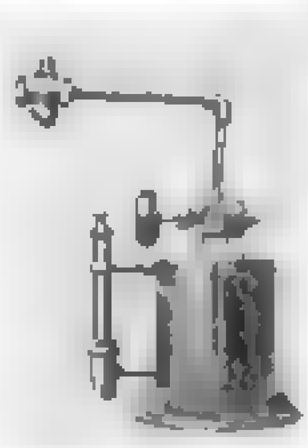
This difficulty can be overcome by using a plug like the one illustrated. It is made of cast iron and has two threads near the shoulder so that it can be quickly removed or inserted. Four or more holes are drilled through the body ahead of the threads and spaced to correspond with the pitch of the thread. Bits of waste or wicking are tucked in these holes when it is desired to clean the thread.

The head of the plug is drilled for a handle, which is made from a piece of cold rolled steel or drill rod.

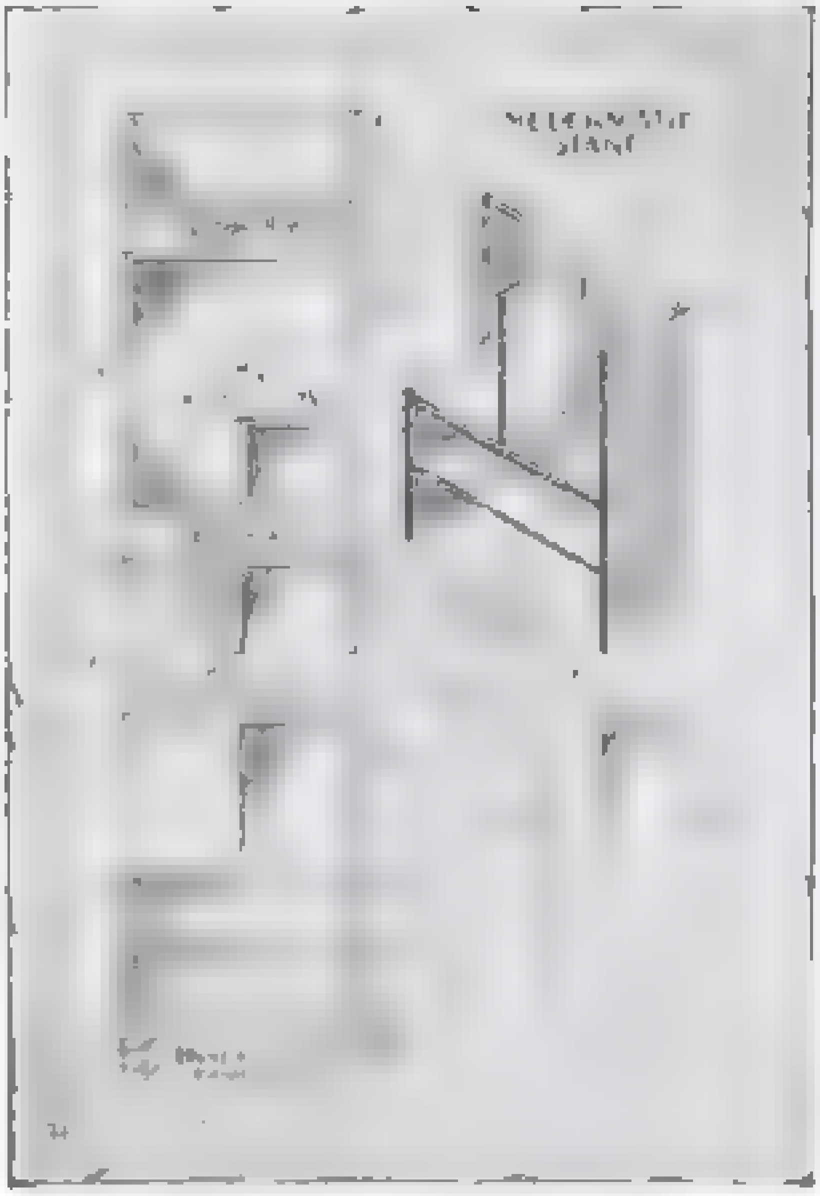
If such a plug is kept in the hub of each chuck and faceplate when not in use, it will keep out all dirt and grit and the threads will remain in good condition. It takes considerably less time to put one of these plugs in the hole than it does to clean the threads by any ordinary method. —H. L. WHEELER.

Scrap Parts Converted into Spray Gun for Painting

THE accompanying illustrations show a practical paint spray gun made from an old blowtorch and a regulating valve bracket from a scrap lubricator. The air is carried into the head through the feed glass drain vent, retapped to take 1/4-in. pipe. The outer nozzle was the only turned part made, and it was secured by the original glass packing nut. For a small homemade affair, it has proved handy in covering parts about the shop not conveniently worked with a brush. F. B.



The spray gun and detail of the nozzle



To make the stand, two sections like that shown in the isometric drawing are nailed together. These are placed 8 in. apart, back to back; then the top, bottom, feet, and minor parts are added. Only simple butt joints are used.

Modernistic Furniture

(Continued from page 57)

shelves of this section, which are ¾ by 13¾ by 26 in., should be planed together respectively to their lengths and widths. If a rabbet plane is available, the sides should be rabbeted on their rear edges to receive the back, as this makes a neater job. The rabbeting, of course, should be done before the assembling. The doors and back should be made from plywood if possible, as it is easier to handle and does not warp or shrink. Each door should be fitted separately.

The upper section, which is constructed in a similar manner, has four dowels glued into the lower ends of the side-pieces. Corresponding holes should be located and bored in the top piece of the lower section, so that the upper section may be placed firmly on the lower section, yet be easily removed.

As to the manner in which these pieces are finished, it will depend mainly upon the kind of wood used in their construction. If this has been selected especially for its beautiful grain, it may be stained and varnished or coated with clear brushing lacquer or shellac so as to give it a high polish. In addition, it may be decorated with ivory, celluloid, or ebony inlays, or with gold and silver leaf or bronzing powders.

For the less skilled workman, it is suggested that the pieces be finished with brushing lacquer enamels. Decalcomania transfers can be added as decorations provided the designs are geometrical or modern in style.

Modern designers often paint or lacquer all the outside surfaces one solid color, and the inside compartments a brilliant contrasting color. The edges of both varnished and colored pieces are often finished in black, silver, or gold. The tendency is to employ the colors used by the ancient Greeks. These are red, yellow, blue, green, gold, and silver. With the recent developments of lacquers, varnishes, spray guns, and the wide diffusion of knowledge of painting methods and modern color schemes, the decoration should be an easy matter for any careful and observing amateur.

Do not overlook the fact that you can obtain a blueprint containing large drawings of both the stand and the bookcase, as well as a completely itemized cutting list, by sending for POPULAR SCIENCE MONTHLY Blueprint No. 88 (see page 102). Other modernistic designs are being prepared by Mr. Hjorth in collaboration with William H. Varnum, Associate Professor of Applied Arts, University of Wisconsin, and these will be published in forthcoming issues. Among the pieces are lamps, smoking stands, folding screens, book ends, and an unusual and very smart and decorative sewing cabinet.

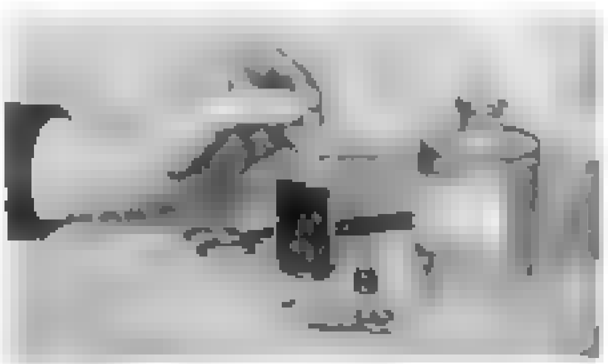
Home Workshop Chemistry

Simple Formulas that Will Save Time and Money

CRUDE natural rubber, which is also called caoutchouc, is soft and elastic. In its crude state, it is obtained from the sap of a number of different trees and shrubs. To render it fit for use it must be vulcanized, which makes it more elastic. If it is further processed it becomes hard rubber.

Few solvents for rubber are known. The weaker acids and alkalies do not affect it, and only a small part is soluble in alcohol and ether. It swells in ether and in the essential oils. Carbon bisulphide is the most common solvent, and it is easily soluble in chloroform and also in benzine and turpentine upon being heated.

Rubber cement, which may be obtained in collapsible tubes and tins at automobile supply stores and in many five-and-ten cent stores, is a useful adhesive in the home. It can be used for mounting photographs and pictures of all kinds. The cement is spread over the entire back of the picture, which is pressed down carefully to avoid the formation of air bubbles. The surplus cement is wiped off and a weight is placed on the picture until dry. This cement has the great advantage over other adhesives in that the prints or pictures will lie absolutely flat and their mounts will not show any tendency to roll.



Placing bits of crude rubber in carbon bisulphide, the most common rubber solvent.

A patching outfit containing rubber cements such as those used for repairing inner tubes can also be used to repair rubbers, rubber boots, and other articles of rubber.

Those interested in art work can make "spatter" drawings easily with the aid of rubber cement. The cement is used for covering the spots on the drawings that are to be left white. It should not be applied too thin. When it is dry the spattering can be done by using a stiff brush and a wire screen to scatter minute drops of ink over the paper. After certain parts have been shaded sufficiently and the ink has been allowed to dry, those parts can be covered with rubber cement and the spattering continued. To remove the yellowish-brown film of rubber from the drawing, simply rub it gently with the fingers. It will peel off.

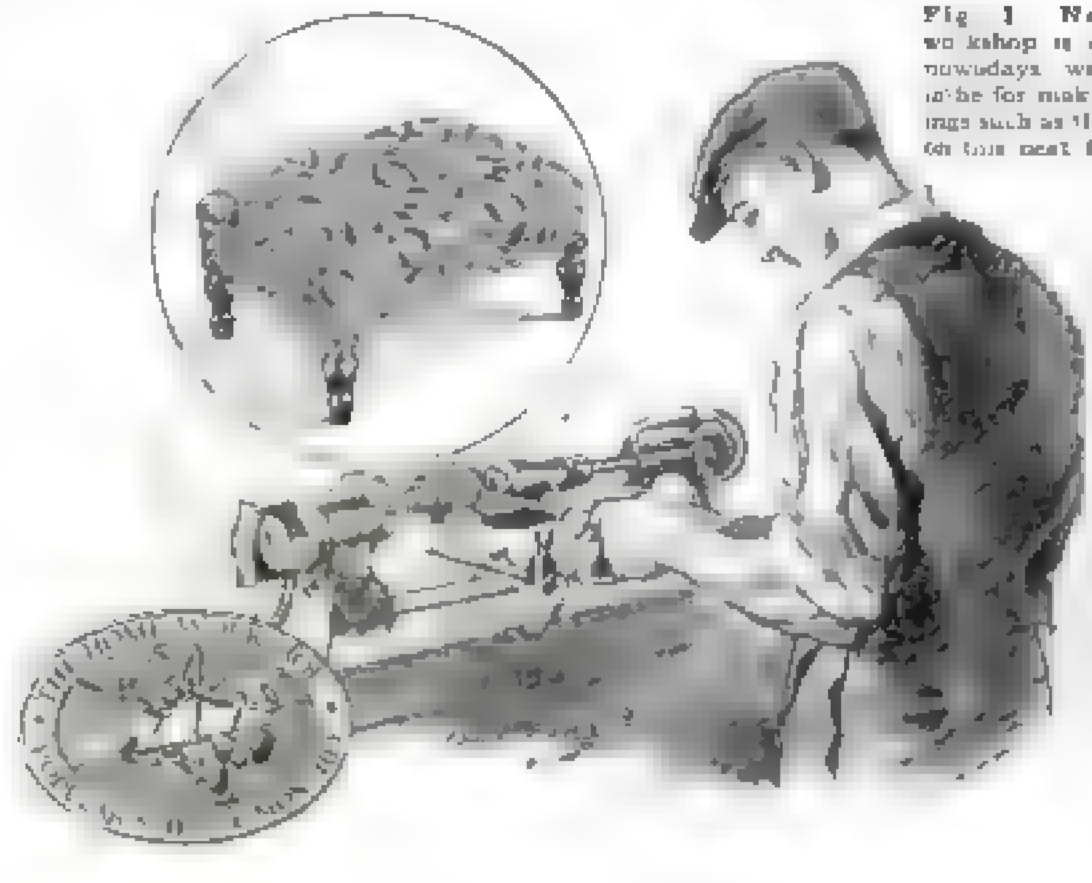


Fig. 1. No home workshop is complete nowadays without a lathe for making turnings such as those used on this neat footstool.

How to Turn Ornamental Legs for a Footstool

HAVING mastered the wood turning exercises and projects described in the preceding articles of this series, we can have much real fun making furniture that is ordinarily beyond the amateur woodworker.

The important thing in furniture construction is not only good workmanship, but also—and perhaps to a greater extent—good design. The amateur furniture maker should cultivate a taste for good design by studying the characteristics of the different historical periods and comparing modern creations with authentic museum pieces.

The footstool illustrated in Fig. 1 is a simple project from the standpoint of both wood turning and joinery. Notice that the upper parts of the four legs (Fig. 2) are square, and that the rails are joined with dowels to this square part in such a way that the outside faces of the legs and rails are flush.

When getting out the stock for the legs, cut it somewhat larger, say 1¾ in. square, so as to allow for the final squaring after the legs have been turned. In this way any unevenness in centering or any slightly broken-off corners can be remedied.

When beginning the turning, lay off the square part by squaring a pencil line all around on the four sides of the piece. Start cutting a little outside the lines with a very sharp skew chisel, rest its edge on the T-rest and bring the point gradually in contact with the wood. This will nick the corners of the square piece. After a light cut with the skew chisel, cut down to the same depth with the parting tool. Then repeat the process until the parting tool is in contact with the wood at all points. Round off the rest of the piece with a gouge and finish to the proper diameter as described in previous articles.

Finish the square cut with the skew chisel, as shown in Fig. 3. If by accident the square corners should be broken off beyond repair, turn this part of the stock down to form a round tenon ¾ in. in diameter and 1 in. long. Blocks 1½ in. square and 1¾ in. long then may be cut, a ¾-in. hole 1 in. deep bored in the center of one end of each, and the turned legs afterwards glued to them.

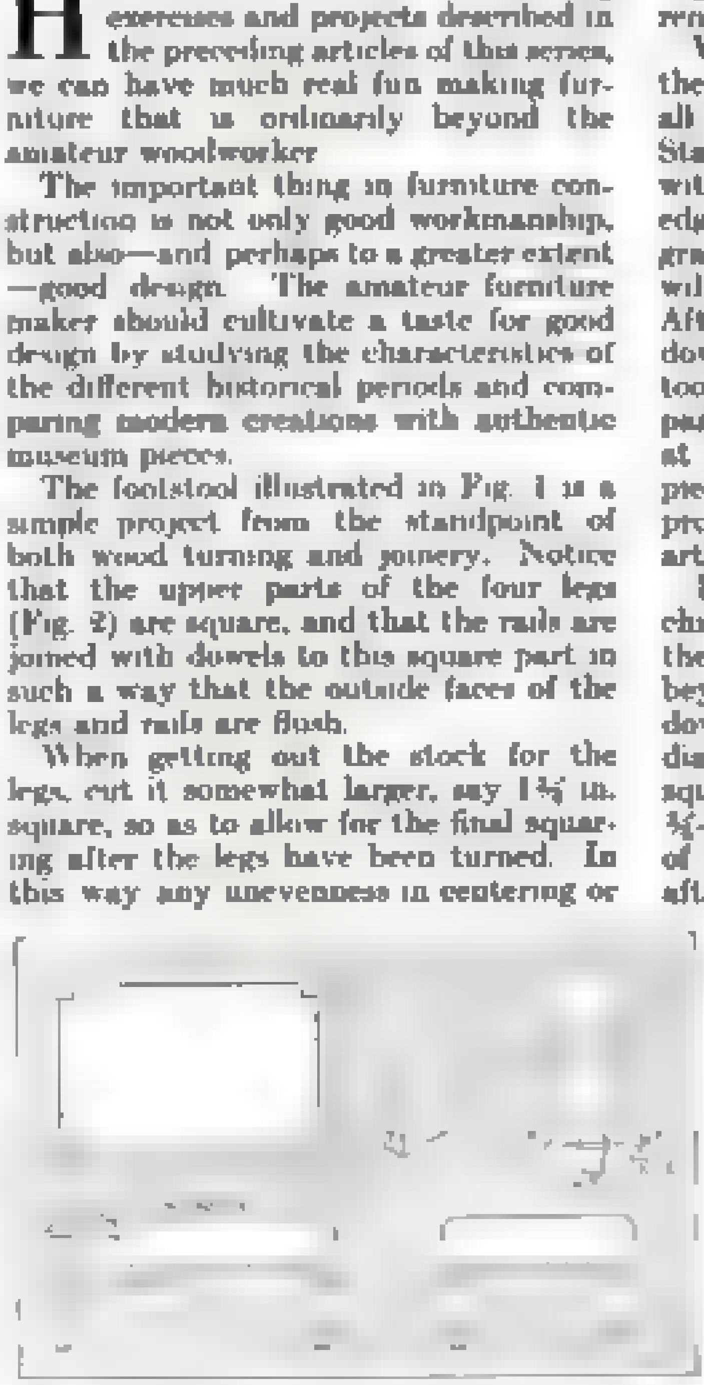


Fig. 2. Side and end views of the footstool, top view of the framework, and details of the legs and doweled joints.

If you succeed in turning the legs in one piece, the square part is planed down to 1½ in. so that the turned part is perfectly centered. The rails are then squared to dimensions. Be careful to see that all the ends are square and that each pair of rails are exactly the same length.

Mark the outside faces of the legs and rails and set a marking gage to half the thickness of the rails. Gage a line through the center of the ends of each rail, and corresponding lines (two) on each leg, holding the block of the marking gage against the outside faces of (Continued on page 96)

Wood Turning

(Continued from page 94)

the legs and rails. Next set the gage to ½ in. and mark lines from the top edges of legs and rails crossing the lines already marked. Then set the gage to 1¼ in. and mark another set of lines also from the top edges, crossing the vertical lines first marked. Bore holes ⅜ in. in diameter and ¾ in. deep at all points of intersection. If the work has been accurately done, the rails and legs when joined will be flush both on the top and on the sides. If it is found that a hole has been bored inaccurately glue a ⅜-in. dowel into it, cut off the dowel flush, and bore a new hole after the glue has set.

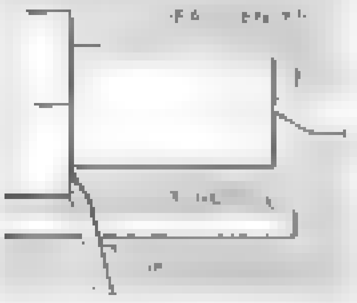


Fig. 3. Finishing shoulder of square cut on the leg.

When all joints fit perfectly the legs and rails may be glued together. It is best to glue either two ends or two sides first and let the glue set, rather than attempt to glue the whole stool together at once.

The stool may be upholstered very easily as follows: Smooth off any little unevenness from the joints, nail a piece of ½-in. plywood to the top, and plane it flush with the sides of the stool. Plane a bevel on the plywood top on all four sides and tack a piece of webbing or burlap about 8 in. wide to it so that the tacks are driven into the center of the bevel and the burlap hangs over the sides of the stool.

Buy 1½ lb. of fine tow from an upholsterer and form it into an even roll ¾ in. in diameter. Place it on the bevel and fold the burlap over it, tacking the burlap to the plywood top so that a hard roll is formed all around the top edges of the stool.

Place a layer of tow evenly over the top of the stool, picking or separating it well so that it becomes light and fluffy. Stretch a piece of muslin over the tow and tack it to the sides of the rails near the lower edge. Drive the tacks only part way into the wood, because the muslin must be restretched several times and the tow manipulated until the seat is smooth.

Hair is a better material to use for this purpose than tow, but more expensive. A layer of hair or moss on top of the tow will improve the seat.

After the muslin has been finally tacked in place it is covered with a piece of upholsterers' blue cotton wadding, after which the covering, such as tapestry or leather, is stretched over it and tacked. The edges are trimmed with a pair of scissors and covered with a narrow band or "gimp" made of the same material or bought ready-made to match. This is nailed in place with upholsterers' fancy nails.

The legs should be stained and finished before the covering is tacked in place.

This is the fifth in a series of articles on wood turning by Herman Hjorth, author of "Reproduction of Antique Furniture" and a distinguished teacher and craftsman. The sixth will be published in an early issue.

Materials for Footstool

No. Pcs.	T	W	L	Part
4	1¾	1¾	6	Legs
2	⅞	1¾	7	Rails
2	⅞	1¾	11	Rails
1	½	13	14	Top
1		15	20	Muslin
1		13	16	Cotton Wadding
1		15	24	Covering

1 lb. fine tow, tacks, and upholsterer's nails.

All dimensions are in inches

How to Make a *Bremen* Model

(*Continued from page 59*)

type. First install the bamboo diagonals in the fuselage between stations Nos. 4 and 5. They are a scant $\frac{1}{16}$ in. sq. The lower end goes $\frac{1}{4}$ in. back of station No. 4, the upper end meets the longeron at station No. 5. The horizontal follow through strut is bamboo, a scant $\frac{1}{16}$ in. sq. Refer to the full size front view of the undercarriage on Blueprint No. 89 and bend the struts, which are bamboo, a scant $\frac{1}{16}$ by $\frac{1}{8}$ in., so they will run across to the inside of the longerons and up the vertical struts $\frac{1}{2}$ in., where they are cemented and bound to the longerons with a few wraps of silk thread. The glossy side of the bamboo is toward the center of the airplane. The lower ends of the front struts should be $\frac{1}{16}$ in. back of the vertical to give a true Junkers appearance. The front struts extend from station No. 4, the rear struts from No. 5. The lower ends are $4\frac{1}{4}$ in. apart viewed from the front.

The undercarriage bracing tripod is bamboo, $\frac{1}{16}$ in. in diameter. It extends $1\frac{1}{4}$ in. below the fuselage. The lower ends are bound together and cemented. The upperward ends are bent parallel to the diagonals, bound in place on the inside, and cemented. The end of the tripod when viewed from the side should point to the undercarriage axles. The spacers which run from the tripod to the undercarriage are No. 8 piano wire. The ends are bent in a tight loop running parallel to the struts and bound in place. The axles are made of piano wire a shade over $\frac{1}{32}$ in. One end is bent in a tight loop $\frac{1}{16}$ in. long and bound to the undercarriage; the other end is bent out horizontally and extends outward $1\frac{1}{4}$ in. When assembling the undercarriage, work carefully and sight it up frequently to assure its alignment.

The Bremen taking off. It leaves the ground after a 4-ft. run and climbs rapidly.

The wheels are $2\frac{1}{2}$ in. in dia. and $\frac{1}{4}$ in. through the hub. They are made of manila drawing paper. Cut out circles of paper and make flat cones, cementing the joints. Double the cones for each side of each wheel for strength. Cement small copper washers to each cone inside to form a hub bearing. These should be cemented securely. Then cement the cones in pairs. When the wheels are dry, mount them on the axles and secure from slipping off with a few wraps of thread around the end of the axle. Cement the thread.

THE tail skid is No. 8 piano wire. Bend one end in a tight loop $\frac{1}{2}$ in. long and bind and cement it to the rear lower end of the fuselage. It should extend downward $\frac{1}{4}$ in. and rearward $\frac{1}{2}$ in. The lower end should be turned up slightly so it will slide smoothly along the ground.

The front spar beds are bamboo $\frac{1}{4}$ by $\frac{1}{16}$ by $\frac{1}{16}$ in. and extend upward from the lower longerons and rest against the front side of the struts at station No. 4. They are cemented in place. The rear spar beds are bamboo $\frac{1}{4}$ by $\frac{1}{16}$ by $\frac{1}{8}$ in., and are mounted in the same manner at station No. 6.

The remaining fuselage diagonals between stations Nos. 1 and 2, Nos. 2 and 3, and Nos. 3 and 4 should be installed. They are a scant $\frac{1}{16}$ in. square.

The next step is the wing center section. Cut two spars of white pine $\frac{1}{4}$ by $\frac{1}{8}$ by $6\frac{1}{8}$ in. Through the ends of each spar cut a slit in the $\frac{1}{4}$-in. face $\frac{1}{2}$ in. long and $\frac{1}{32}$ in. wide. The wing pins are piano wire a shade over $\frac{1}{32}$ in. in diameter. Bend a flat loop $\frac{1}{2}$ in. long and $\frac{1}{8}$ in. wide. Cut off the wire so that the over-all length, including the loop, is $1\frac{1}{2}$ in. Cement and bind the loop of one piece into the slit in each spar end. Mount the spars firmly on their beds and against the vertical struts. Cement and bind them to the vertical struts with a few wraps of thread. The spars should extend 2 in. on each side of the fuselage.

TO COMPLETE the wing stubs, six No. 1 ribs must be made. The Junkers plane uses a special wing curve, but for simplicity this model has a curve known as the Clark "Y." The Clark "Y" is a very efficient curve and is widely used by American constructors. Col. Lindbergh's monoplane has a Clarke "Y" wing curve. The Clarke "Y" is easy to make because the entire under-surface is flat with the exception of 10 percent at the nose, where it turns upward slightly in a radial curve—only $\frac{1}{8}$ in. in our largest ribs, which are 6 in. long.

The wing ribs are shown full size on the blueprints, but you may be interested in knowing how to lay them out in case it were necessary to do so. On the side view the No. 1 rib is $\frac{3}{4}$ in. deep at its deepest point. On the top view the rib is 6 in. long. Draw an accurate rectangle $\frac{3}{4}$ in. high and 6 in. long. The rib is to be drawn within this rectangle. On the top view the front spar is located $\frac{3}{4}$ in. from the leading edge. Locate this with a dot on the lower 6-in. line of the rectangle. The rear spar is $4\frac{1}{4}$ in. from the leading edge. Locate this with a dot on the lower line. The highest part of the curve is back from the leading edge 30 percent of the chord, or rib length. Locate this point with a dot on the top 6-in. line. The height of the curve at the rear spar is $\frac{1}{2}$ in.; locate this with a dot. The lower line of the curve is flat from the front spar to the rear end of the rib, but it turns up at the nose $\frac{1}{8}$ in., so locate a dot for the leading edge of the curve. Look at the curve shown in the side view of the wing stubs; then duplicate its shape within the rectangle, being sure the lines travel through the dots. It sounds hard, but after a few practice drawings you will find it is not difficult. Now from the spar depth at the rib locations you can always get the proper cross sections and draw your own rib patterns. First, take the dimensions of your rectangle from the side and top view, and take the spar locations from the top view. Then draw the curve, keeping in mind its general characteristics.

The ribs are made of balsa wood $\frac{1}{16}$ in. thick. Transfer the rib and spar hole outlines on the balsa. Break a razor blade in two so you will have a very sharp-pointed triangular piece to cut with. Cut out the ribs and spar holes accurately.

There are three ribs in each wing stub. One is cemented flat against the fuselage side. Cement is run around the spar holes and the rib is cemented well to the various struts of the fuselage. This forms the typically strong Junkers center section. Another rib is imbedded to the spars 1 in. from the fuselage, and another flush with the spar end. Just a touch of cement around the spar holes is all that is necessary on these ribs.

The leading and trailing edges are bamboo, a scant $\frac{1}{16}$ by $\frac{1}{16}$ in.

(*Continued on page 97*)

A SMALLER, SMARTER . . . AND HUSKIER . . . ELGIN

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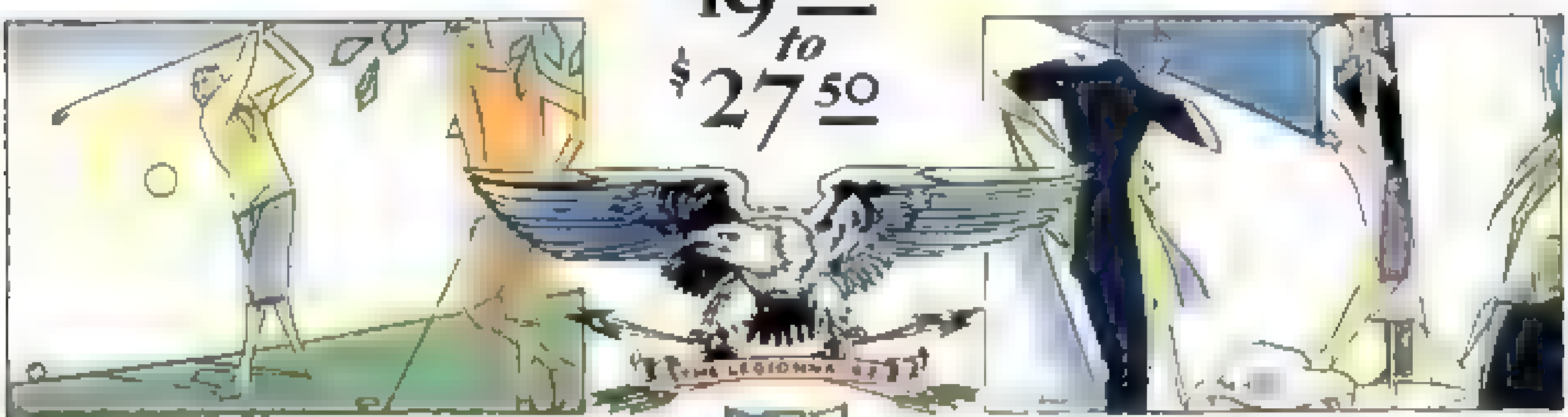

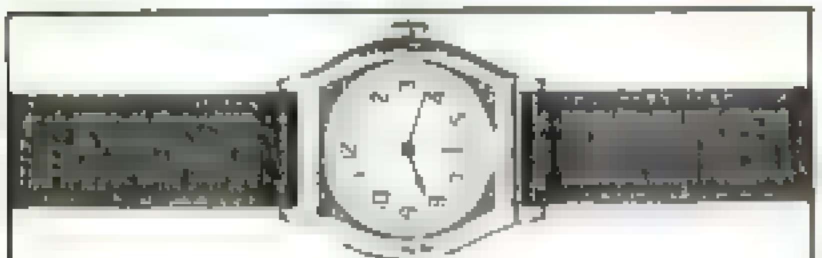

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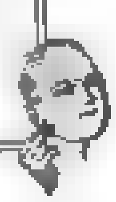


Have you tried the new Listerine Shaving Cream?

Cools your skin while you shave and keeps it cool afterward. An outstanding shaving cream in every respect.

How to Make a *Bremen* Model

(Continued from page 96)

They are cemented into notches in the rib ends. The edges do not continue through the fuselage. Be sure to install the wing stubs accurately and make the ribs carefully. You now have the fuselage frame complete with wing stubs, wheels, undercarriage, bulkheads, and tail skid. To check your work, the whole assembly produced so far should weigh not over three quarters of an ounce.

For the two wing panel frames, cut the ribs accurately from 1/16 in. thick balsa. The wing panel spars are white pine 13 in. long. They are ¼ by 3/16 in. at the inner end and taper to a scant ⅛ by 3/32 in. at the ends. The inner ends of the spars are angled so they will fit up flush with the wing stub spars when the panel is set at the proper dihedral. The tip of the panel will be 1½ in. higher than the wing stubs. Drill or force a brad in the inner ends of the spars to make a hole for the wing pins after reinforcing the outside of the spar with a few wraps of silk thread and cement.

ASSEMBLE the wing by sliding the ribs in place on the spars. The ribs are spaced 2¼ in. apart. There are 7 of them. The inner rib is the No. 1 size. The tip rib, or No. 7, is 4½ in. long and 5/16 in. deep at its greatest depth. Be sure the inner rib is at the correct angle to the spars so it will fit flush against the wing stubs.

When the panels are properly assembled, cement lightly around the spar holes and align the panels. Then on the left panel warp the front spar upward about 1/8 in. This gives increased incidence to the left wing and counteracts the propeller torque. Now let the panels dry thoroughly.

Cut the bamboo strips to carry out the spar tips. These are 1/32 by 1/16 in. and 1½ in. long. Bind and ambroid them to the ¼-in. spar overhang and then install the wing edging. The edges are bamboo, a scant 1/32 by 1/32 in., and are ambroided in notches in the rib ends, the same as the wing stubs. The tips are bamboo 1/32 in. sq. Bend them over a candle flame and install around the spar ends and through the notches in No. 7 rib; then splice them neatly to the edges between rib No. 6 and No. 7.

The tail wing or stabilizer is double surfaced and made entirely of bamboo. The span is 11 in. and it is 3½ in. wide. It has one spar of bamboo 1/16 by 1/8 in. The spar is located 1½ in. from the leading edge. There are four ribs. Each rib has an upper and lower piece of bamboo by 1/64 in. There is a center compression strut or rib of bamboo 1/32 in. sq. Install a double rib 1½ in. on each side of the center; the other ribs go 3¼ in. from the ends. The edging is bamboo, a scant 1/32 in. sq. Align the stabilizer, being sure it is flat.

THE rudder is bamboo. The spar is 1/16 by 1/8 and 4 in. long. The lower rib is double. Each side is made of 1/64 by 1/32 in. bamboo. The upper rib is single, a scant 1/32 in. sq. The outline is bamboo, a scant 1/32 in. sq. Assemble the rudder in the same manner as the stabilizer, carefully preserving its shape.

To give a true Junkers appearance, the model must have a radiator and motor cowling. The radiator is made of balsa wood. Cut two pieces of balsa 1/16 by ⅜ by ¾ in. Cement these as shown to the sides of the fuselage nose struts; then cut the top piece of balsa. The highest part of the curve is ⅛ in. Cement the top cap in place and cover the front of the radiator with manila paper. Trim away the necessary paper so the motor stick can slide in place.

The cowling formers are ⅛ in. high and made of 1/16 in. thick balsa, the stringers are of bamboo, a scant 1/32 in. sq., and are ambroided in notches in the formers.

The motor stick is white pine ⅛ by ¼ by 14 in. Make a (Continued on page 98)

How to Make a *Bremen* Model

Continued from page 77

propeller hanger of $\frac{1}{32}$ in. diameter piano wire. Bend a tight loop in the wire just large enough for the propeller shaft, then bend the wires rearward and upward $\frac{1}{4}$ in., then parallel to the motor stick $\frac{1}{2}$ in. Here it is bound and cemented firmly to the motor stick. Run the thread binding back another $\frac{1}{4}$ in. behind the hanger so the front clip will grip the binding and keep the motor stick from sliding back and forth in the fuselage. Make a rear hook as shown and bind and cement it in place.

The *Bremen* has a metal propeller and to represent its shape the model has a "toothpick" type propeller. Mark out the blank as shown on the blueprints on a soft block of white pine. The blank outline can be cut with a knife or fret saw, but it is much easier to have it cut on a band saw at a planing mill. Carve the propeller carefully. The rear side is concave and the front side convex. The blade's cross section should resemble a wing curve. After the actual carving is completed, round the tips slightly and trim away the hub as shown in the side view of the model. Sandpaper the blades until they are smooth, and balance the propeller carefully so it will not vibrate when running.

THE propeller shaft is $\frac{1}{32}$ in. diameter piano wire. Bend one end in a tight loop and sink into the wood at the hub to key the propeller in place and touch the end of the shaft with cement. Install a small copper washer for a thrust bearing. Then bend a rubber hook on the other end of the shaft, which should be just long enough to have the rubber hook on the inside of the fuselage. Make an S-shaped hook for the rear end so a winder can be used, and loop on eight strands of $\frac{1}{32}$ by $\frac{1}{8}$ in. model airplane rubber.

The covering on this model is Japanese rice paper, a thin, gauzy, but very tough material, after it is coated with banana oil. You may also use Japanese tissue paper or China silk. For covering with rice paper or tissue, stick the covering on a section at a time with banana oil, and dope with one coat of banana oil. For covering with China silk, stick the covering on with airplane nitrate dope, and dope with one coat of nitrate dope diluted with three or four parts of acetone. The rice paper is the covering the writer used and recommends. All these materials, as well as rubber, bamboo, special cement, etc., may be purchased from model airplane supply houses.

THE wing panels are covered on both sides. Cover the fuselage a section at a time. Leave the windows between stations Nos. 6 and 7 open so that the motor stick can be reached. The upper horizontal bay of the fuselage between stations Nos. 3 and 4 is covered with glassine to represent the cabin window. Cover the top side of the stabilizer and one side of the rudder, and coat with banana oil, then coat the covering for the other side before sticking it in place. In this way one can keep the covering surfaces from sticking together through the thin panels.

After the covering is completed, cement the stabilizer to the fuselage and then cement the rudder in place. Be sure they are aligned.

The shock absorber housings on the undercarriage are made of manila paper cemented in place. They are 1 in. long and $\frac{5}{8}$ in. wide, slightly peaked at the top. They go $\frac{1}{2}$ in. down the struts from the fuselage.

The undercarriage wheels and front end of the motor stick may be lacquered silver and the model lettered as shown in the photographic illustrations and on the blueprints. The lettering indicates the manufacturer and name of the ship, and the numeral D 1167 is the license number. The lettering is flat black.

It is important when building this model to keep carefully to the specified dimensions so that the finished model will balance properly in flight. If the model is slightly out of balance, you can alter it somewhat by shortening or increasing the length of the motor stick.

To fly the model, press the motor stick in place so it projects about $\frac{1}{2}$ in. in front of the radiator. Engage the rear clip by inserting the forefinger through the window, holding the thumb on vertical strut No. 6. Then, with the thumb on top of the radiator, press the front end into the clip with the forefinger. The stick will go into place with a businesslike snap. Be sure the wing pins slant up at the correct angle. Insert the pins in the wing panels and press the latter gently in place.

The model flies fast. Glide it first when there is little wind. It should make an easy glide to the ground. Wind it a hundred turns by hand and launch it with the wind in level flight. It will soar away beautifully. Now for the big flight. Disengage the motor stick. Have someone hold the propeller. Hook the S-hook to a winder and stretch the motor out about two and a half times its normal length. It can be wound smoothly this way from 550 to 900 turns. Hold the propeller and snap the motor stick in place carefully. Hand launch it in level flight with the wind. You will be surprised that this scale model will make such a beautiful flight. This model will take off and fly in excellent fashion under its own power. Just wind it up fully and set on a smooth surface where it can have a run of three or four feet.

The complete airplane should weigh 2 ounces.

FOR those who want to try a more difficult model, the little ship can be made much lighter by using balsa wood where the design calls for white pine. Balsa wood is very soft and is easily damaged while working on it, so you must be very careful and accurate.

Make the nose of the fuselage 1 in. longer and shave all the parts of the stabilizer and rudder a little thinner. Make the propeller hub $\frac{1}{8}$ in. wider when viewed from the front. Make the motor stick $\frac{1}{4}$ by $\frac{1}{8}$ in. Make the spars $\frac{1}{16}$ in. deeper and $\frac{1}{32}$ in. thicker. And, of course, this will mean the ribs must be $\frac{1}{16}$ in. higher throughout. Proceed in construction the same as with white pine. The balsa model will fly on less rubber. It will be considerably more difficult to produce, but if you are a good workman the fine flying results are well worth the extra work.

Blueprints to Aid You in Building Planes

AS IN the case of ship models, POPULAR SCIENCE MONTHLY was the first to realize the need for issuing simplified blueprints to aid its readers in constructing flying airplane models. Five are now available in addition to the new *Bremen* model: No. 38 an R.O.G. tractor of 16-in. wing span; No. 69, a 3-ft. flying model of the *Spirit of St. Louis* (this design was the first of the kind published in any magazine); No. 82, a single-stick, 30-in. hand-launched model; No. 85, a 35-in. twin pusher; and No. 87, a 30-in. tractor seaplane model. In ordering any of these, please use the coupon on page 102.

Hints for the Outdoor Man

(Continued from page 88)

bottom and ran through them a couple of stiff wires. The pie tin rested conveniently on these and the whole contraption was propped over a bed of hardwood coals. Later half a wire toaster replaced the two wires, and, with this addition, the oven did service over many a camp fire as well as on sundry oil stoves.

HIGH on the club's flagpole Ig Loo twirled his big-bladed double paddle in shimmering circles. A queer place for a paddler, but Ig had been there since last fall, his kayak bucking the seas of swirling air.

Ig, as you probably have guessed, is a little wooden Eskimo, seated in a wooden kayak, with a wooden paddle (Figs. 1 and 2, page 88). He serves as weather vane and ornament.

If you have made model boats, the shaping of his kayak from a piece of white pine or cedar 1 by 2 in. will be an easy matter. Coaming and cockpit are merely an oval piece of ⅛-in. material glued fast to the deck.

A hole large enough to receive loosely the head of a tenpenny nail is bored in the center of the cockpit and nearly through it; from the center of this hole proceeds a smaller hole to fit the brass tube with which it must be bushed. Thrust through this tube, the nail furnishes a pivot on which the kayak spins easily.

Ig himself is carved and a saw cut is made in his hands and arms to take the brass or tin piece holding the paddles. His arms may be whittled separately, or may be a one-piece extension from the body, tapering at the hands to the width of the brass or tin. This bit of metal is shown in Fig. 1, as is the bent wire member upon which the two parts of the paddle handle are impaled. It is best to whittle the parts to about ¼ in. diameter, work the wire into the end for ½ or 1 in., and then cut and sand the handle to its final size—somewhat less than ⅛ in. at the large end and smaller still where it flattens and broadens to meet the blade. The blades are cut from Bristol board, fiber, or the like and are glued to the outer ends of the paddle handles.

Set the assembled swivel in the slotted arms, insert a pair of double-pointed brads in the cockpit, one forward and one aft of the pivot, and force the paddler in place.

While the sketch shows approximately how to adjust the paddles, and while your canoeman may paddle correctly at the first attempt, he may paddle backward furiously, or refuse altogether. However, the paddle handles have not yet been glued to the wire and can be turned with the fingers—an angle of 45 degrees gives best results—until Ig is doing his stuff in rare good form.

A simpler way to carry out this scheme is to cut man and canoe from a piece of ¼-in. white pine in profile only. Round the figure and point the ends of the canoe judiciously.

If very high winds are likely to be encountered, it would be well to place the pivot at the forward end of the cockpit instead of in the exact center and to lengthen the rear half of the canoe an inch or so, thus steadying the craft.

How to Cement Rain Pipes

WHERE a galvanized or copper downspout from a roof gutter enters the tile sewer opening, it is sometimes necessary to renew the cement filling, which breaks off and allows the water to flood out during heavy rains. Such a filler may be mixed from any sharp sand (rescreened torpedo) and Portland cement. One part of cement to two parts of sand is a strong enough mixture. If the hole between the pipe and the sewer tile is large, wrap a piece of rolled-up newspaper around the pipe to fill the hole and prevent the cement from dropping down and filling up the tile.—F. N. V.

Lt. A. R. McCracken, U. S. N., Describes an Easy Way to Make

Sails for Ship Models

Linen Tracing Cloth Is Used—Its Natural Curl Gives a Picturesque, Wind-Blown Effect

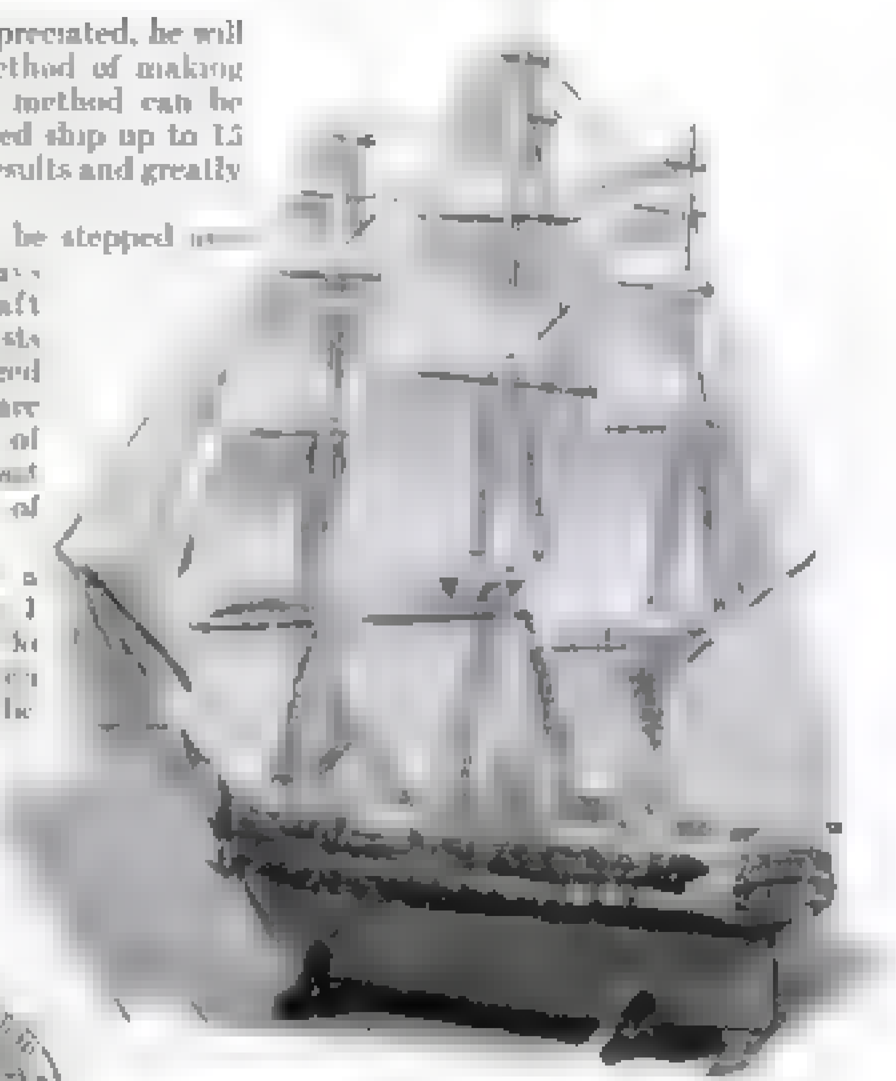
TWO questions are of vital interest to everyone who admires ship models and wishes to build them. One is what size to make the model. A large model requires considerable space for building as well as for display, yet small models generally have minute and complicated details which make their construction much more difficult. The second point is whether to give the model sails. Model plans often omit sails on account of the problem of rigging them, but the average builder usually would prefer to create, if he could, something that has the tang of the sea and the grace of the sailing ship.

A satisfactory solution of these two problems is shown in the photographic illustrations. A model of "Old Ironsides" was built from the plans which appeared originally in POPULAR SCIENCE MONTHLY. The model, however, was made half size; it has a 10-in. hull and is only 12 in. tall. The small size and the method of rigging the sails made it possible to eliminate many details, the absence of which in a large model without sails would be conspicuous.

By this elimination a sketch model and not a scale model is produced. The photographs will enable the reader to tell if the result is to him sufficiently sea-going in spirit or whether his knowledge of detail and his instincts of completeness are offended. If he is a professional craftsman with a mastery of nautical detail, the latter is likely to be his opinion, but if he makes things for the pleasure of creating and wants to build a creditable model without spending months on details that are often unappreciated, he will be interested in this method of making and rigging sails. The method can be used for any square-rigged ship up to 15 in. tall with trim, clean results and greatly reduced labor.

While the masts may be stepped [illegible] the shrouds and backstays rigged, the fore-and-aft stays between the masts cannot be completely rigged until after the sails are hoisted, but one end of them may be made fast while there is plenty of working space.

To design the sails, a drawing [illegible] must be [illegible] the [illegible] distance between the [illegible] must be known. When [illegible] with [illegible] the [illegible] are [illegible] ferent [illegible] from their [illegible] on



A model of the frigate *Constitution*. It has a hull 10 in. long and is only 12 in. tall

a model that does not carry sails. The fore-and-aft stays from mast to mast originate at or just beneath a doubled section of mast and run between the yardarm and the lower edge of the sail just above that yardarm.

The width of each sail is [illegible] in. less than the length of its yardarm. The vertical dimension is greater than the actual distance between yardarms to allow for bellying, and the extra allowance is $\frac{1}{4}$ in. for each 1 in. of distance between the yards. Yardarms which are to be 2 in. apart, for example, will carry a $2\frac{1}{4}$-in. sail. Lines *AB*, *CD*, *EF*, *GH* and *IJ* are, therefore, drawn so that each is [illegible] in. less than the corresponding yards, and the distances *AC*, *CE*, *EG*, *GI* and *IK* depend upon the allowance for fullness, as explained above.

When these lines have been laid down on a center line, draw the edges of the sails as shown and mark the segments which are to be cut out. Each segment should run to a point $\frac{1}{16}$ in. from the edge of the sail. The height of each segment on the center line is the same as the extra amount allowed for fullness.

When the design is completed, all the sails for one mast are made in one piece from draftsman's (Continued on page 101)

Another view of the model. The deck hatches are constructed of original wood taken from "Old Ironsides" in the work of repairing her.

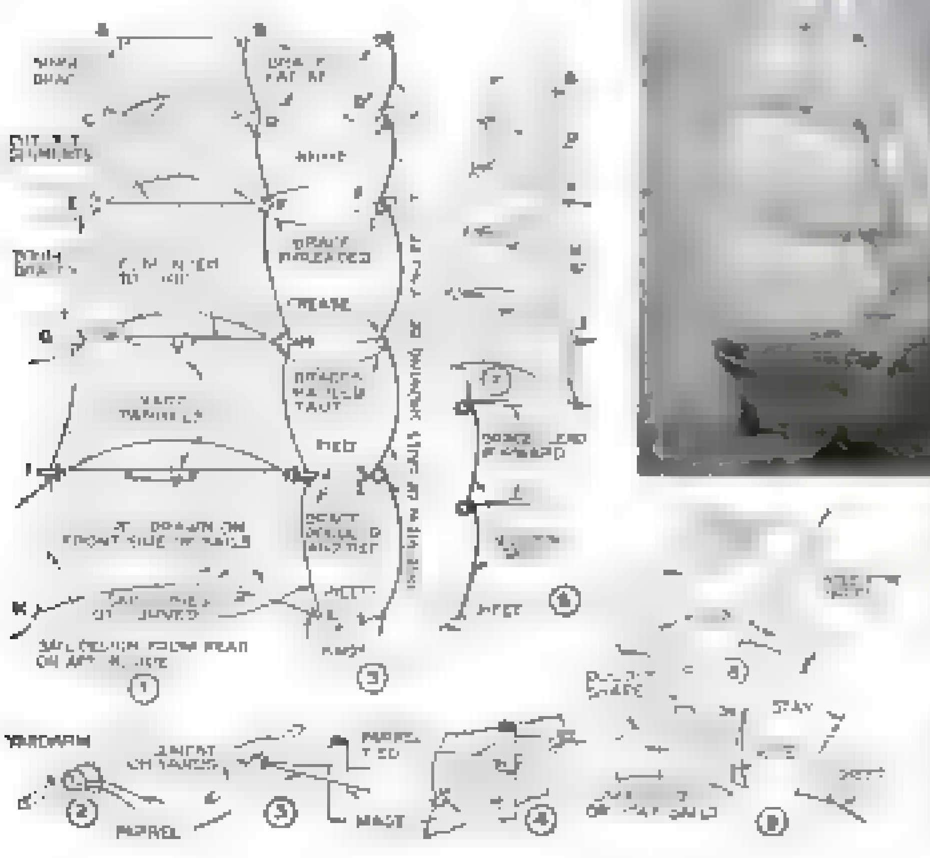


Diagram showing how the sails are laid out for any type of square-rigged model not more than 15 in. high over all.

Ship Model Sails

(Continued from page 100)

tracing cloth that has been rolled up tightly and has acquired considerable curl. Thumb-tack it over the drawing with the inside of the roll down. Trace the sails lightly in pencil and draw light vertical pencil lines about $\frac{1}{16}$ in. apart on all of them to simulate seams.

With a needle, punch holes as indicated, one at the side of each sail even with its top edge and a second hole not more than $\frac{1}{8}$ in. beneath it. After the holes are punched, remove the tracing cloth, cut the outline and the segments with manicure scissors, and crease the remaining ends of lines *CD*, *EF*, *GH* and *IJ* in the opposite direction to the concavity of the roll.

At the centre of each yard loop a double thread (Fig. 2), and haul it taut (Fig. 3). Next lead long threads through each pair of holes in the sails as shown at *IF* and *F*. Run a line of quick-drying cement along a yardarm on the side opposite the ends of the loop (Fig. 3), lay the sails concave side up, and press the cemented yardarm along the upper edge of the proper sail, as at *GH* (Fig. 1).

FIGURE 1 represents the sails with their concave side up or as viewed from aft, excepting that it also shows the vertical seam lines, which in reality are drawn only on the opposite side. Only one hole is punched at *A* and *B*, the thread passing through them and around the top edge of the sail. At *K* and *L* a single thread with a knot in the end is hauled through for a sheet. Figure 7 shows the entire sail assembly ready to lash to the mast (the starboard braces are not shown full length). Each yard is lashed at the proper place on the mast as in Fig. 4.

Lifts are omitted, as it was found that in such a small model they detract from the appearance of the bellied sails. The skysail lift, however, is conspicuous, and as only a single brace is required at the skysail yard (*A* and *B*, Fig. 1), one of the threads from each end of the yardarm is carried up the mast and the two ends tied together around the mast.

A single brace is also required at *C* and *D*, the royal yard, and one of the ends is clipped close to the knot after a small drop of cement has been placed on it. When all the yards have been tied to the mast, a drop of cement is put on the knots and the ends are clipped.

The fore-and-aft stays between the yards are led through the proper openings between yards and sails, and secured. When the stays are made fast, the staysails, trysails, and jibs (Fig. 8) may be added. Cut them out of tracing cloth, leaving a $\frac{1}{16}$-in. flap along the side that is bent to the stay. Fold the flap over, run cement down the crease, and hook the flap right over the stay.

Remember in marking jibs and staysails that the seams run parallel to the after edge of the sail. Do not cut the lower and after edges straight; make them curved as shown, to give them life. On very small models the jibs may be cut out double, then spread with glue and folded right over the stay (Fig. 9).

The braces then may be led to the proper mast and the pairs tied together in a square knot on the far side of the mast. Braces from the fore and main yards lead aft, but those on the mizzenmast lead forward to the mainmast. This must be remembered when lashing the mizzen yards to the sails; the threads must have the ends lead forward as in Fig. 6. The yard is slipped under the loop on the after side of the sail and the knot tied on the forward side, the reverse of the fore and main assemblies.

Any who do not care for the bluish appearance of the tracing cloth can wash off some of the translucent medium with warm water and press the cloth while damp with a well waxed iron. Another method is to paint it with Chinese white water color or white ink.

Blueprints for Your Home Workshop

OUR blueprints can be obtained for 25 cents a sheet. In some cases there are two or three sheets to one subject. The blueprints are complete in themselves, but if you wish the corresponding back issue of the magazine in which the project was described in detail, it can be had for 25 cents additional so long as copies are available.

**Popular Science Monthly,
250 Fourth Avenue, New York**

Send me the blueprint, or blueprints, I have underlined below, for which I enclose ______ dollars ______ cents

No.	Title	Described in Issue of		Price
1.	Sewing Table	Feb.,	'22	25c
2.	Smoking Cabinet	*Mar.,	'22	25c
3.	End Table	*Apr.,	'22	25c
5.	Kitchen Cabinet	*May,	'22	25c
9.	Arbor Gate and Seats	July,	'22	25c
10.	Porch Swing	Aug.,	'22	25c
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13.	Toy Wagon	Nov.,	'22	25c
15.	Workshop Bench	Jan.,	'23	25c
17.	Cedar Chest	*Mar.,	'23	25c
18.	Phone Table and Stool	*Mar.,	'23	25c
19.	Grandfather's Clock	*Apr.,	'23	25c
20.	Flat Top Desk	*Apr.,	'23	25c
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30.	Tool Cabinet, etc.	Jan.,	'24	25c
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37.	Simplified Bookcase	Dec.,	'24	25c
38.	Small Drop-Leaf Table	Jan.,	'25	25c
39.	Salem Chest of Drawers	*Feb.,	'25	25c
41.	One Tube Radio Set	May,	'25	25c
42.	Three Stage Amplifier	*June,	'25	25c
43.	Four Tube Receiver	*July,	'25	25c
44-45.	Pirate Ship Model	*Feb.,	'26	50c
46-47.	Galleon Model	May,	'26	50c
48.	Sailing Yacht Model	*July,	'26	25c
49.	Broom Cabinet	Aug.,	'26	25c
50.	Airplane Model (Rise-off-ground tractor, 36 in.)	*Sept.,	'26	25c
51-52-53.	Clipper Model, *Sovereign of the Seas*	*Oct.	'26	75c
54.	Five Tube Radio Set	*Oct.,	'26	25c
55.	Five Tube Set—Details	*Oct.,	'26	25c
56.	Bird and Animal Toys	Dec.,	'26	25c
57-58-59.	Constitution Model ("Old Ironsides")	Jan.,	'27	75c
60.	Welsh Dresser	Mar.,	'27	25c
61.	Viking Ship Model—Hull	Apr.,	'27	25c
62.	Viking Ship—Details	Apr.,	'27	25c
63-64.	Toy Motor Boat, 29-in. long hull	May,	'27	50c
65.	Six Simple Block Puzzles	June,	'27	25c
66.	Ship-Model Weather Vane	Aug.,	'27	25c
67.	Toy Model of Lindbergh's New York-to-Paris Plane	Aug.,	'27	25c
68.	Magazine Rack Table and Book Trough Table	Sept.,	'27	25c
69.	Flying Model (3 ft.) of Lindbergh's Monoplane	Oct.,	'27	25c
70.	Console Radio Cabinet	Nov.,	'27	25c
71.	Console Cabinet—Details	Nov.,	'27	25c
72.	Doll's House	Dec.,	'27	25c
73.	Doll's House Furniture	Dec.,	'27	25c
74-75-76.	*Santa Maria* Ship Model	Dec.,	'27	75c
77.	Simple Pier Cabinet and Decorative Wall Shelves	Jan.,	'28	25c
78.	Simple Treasure Chests	Feb.,	'28	25c
79.	Electric Radio Set	Feb.,	'28	25c
80.	High Power Unit for Electric Radio Set	Mar.,	'28	25c
81.	Low Power Unit for Electric Radio Set	Apr.,	'28	25c
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83-84-85.	*Mayflower* Model	Apr.,	'28	75c
86.	Racing Airplane Model (35-in. twin pusher type)	May,	'28	25c
87.	Seaplane Model (30-in.)	June,	'28	25c
88.	Simple Modernistic Stand and Bookcase	Aug.,	'28	25c
89-90.	*Bremen* Scale Flying Model (3-ft.)	Aug.,	'28	50c

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Enameling a Door

(Continued from page 80)

edges, then the moldings on the edges of the panels, front and back, then the panel faces, and finally the remainder of the face surfaces.

As to handling the brush, avoid stretching the enamel undercoater out too much. While it should be firmly brushed into contact with the surface, it should not be spread to make a very thin film, as is done with outside paints. Applying the enamel is a bit more difficult. Fill the brush well and, except on the edges, apply the enamel with the idea of covering about one square foot with a brushful. Just flow it on and do not brush it any more than you must to distribute it evenly. Repeat with a second brushful and do not work over the first area until you have coated in about a square yard.

Then wipe the brush on the side of the pot until all surplus enamel has been worked out, and brush over the surface which you have coated. This is to distribute the enamel finally and to pick up any excess. Repeat this series of operations until the whole surface has been coated. Watch closely for about twenty minutes. If too much enamel has been put on in places, it will sag or "curtain." If you act quickly you can brush out the enamel evenly again and eliminate any defects.

In enameling panels, as in Fig. 2, or working around lights of glass in a door, as in Fig. 8, be careful to avoid leaving too much enamel on the edges of moldings and in the corners.

EACH coat of enamel undercoater should be rubbed lightly with No. 00 sandpaper merely to cut off any dust and dirt nibs. Then wash the surfaces clean with a sponge and water and let them dry before painting again.

If a hand-rubbed effect is wanted on gloss enamel, wait two or three days until the second coat of enamel is hard and then rub it with fine powdered pumice stone and water on a piece of soft felt tacked to a block of wood as in Fig. 1. Fold the felt over the ends of the block and place the tacks in the ends; otherwise they would scratch the surface. Wet the enamel with water, wet the felt, and pick up some of the dry pumice stone. Rub with an even pressure up and down, that is, lengthwise of the boards, and do the same amount of rubbing on each division of the area.

Do not rub the moldings and door edges, as it is very easy to cut through the enamel at such places. At most give these places one or two strokes with the rubbing pad, or use a short stiff bristle brush.

If a noticeable amount of dust collects on the first coat of enamel, it is well to water-rub it instead of merely sandpapering it lightly. Do not, however, rub any more than is necessary to cut off the gloss.

The task of rubbing enamel is not nearly as hard as amateur painters are apt to imagine. By stroking off the sludge with one's thumb and inspecting the surface, it is easy to see just how far the rubbing process should be continued to give the smooth, satiny appearance which is so greatly prized and is always indicative of the highest grade enamel work.

A satisfactory effect can be obtained without rubbing through the use of a special semi-flat drying enamel instead of a high gloss enamel. The last coat of this type of enamel does not require to be rubbed.

There is something to be said, too, in favor of using high gloss enamel and letting the last coat stand without rubbing. It is claimed that an unrubbed gloss enamel resists the elements a little better than one which has been rubbed because it presents such a tough, smooth, and unbroken film. Furthermore, the shiny glare of a newly enameled door, even if it is not rubbed, becomes softened quickly enough in most localities because of the dust and soot in the atmosphere and the consequent necessity of frequent washings.

How to Mold Ship-Model Blocks

By A. W. SAWYER

YOU will find that you can hasten and simplify the work of making deadeyes and blocks for ship models by molding them from plastic wood putty of the type sold in cans at hardware and paint stores for filling cracks and holes.

The mold is made by boring holes in a ¼- or ⅜-in. board. When the point of the bit or drill shows through, reverse the drill and bore from the other side so that the edges will be clean. The holes for the deadeyes are left round, those for the blocks are made oblong with a rat tail file. When the required number of holes have been drilled, melt and pour some hot lard through them. Be sure that each hole is well coated. Wipe the surplus lard from the surfaces, clamp the board tightly to another smooth board, making sure that there is perfect contact at all points, and fill the holes with the plastic wood putty. Scrape off the surplus.

Punch holes in the blocks and deadeyes with a small brad while the composition is yet soft—three holes for each deadeye, and one or two for each block, depending upon whether it is to be single or double.

When the composition has hardened,

Wood paste is pressed into molds, drilled, allowed to harden, and trimmed to shape

the pieces can be pushed out with a small stick. The deadeyes will be at least twice as thick as required, but they can be cut in two easily with a safety razor blade. Then the necessary grooves can be filed around them.

The artificial wood is soft enough to be filed, yet it will not check or split and will be found amply strong enough.

Plane Model Built from Our Blueprints

A POPULAR SCIENCE MONTHLY blueprint was used by C. H. Tanner of Urbana, Ill., in building this remarkably realistic model of Lindbergh's trans-Atlantic plane. The blueprint, which is No. 67 in the list on page 104, gives full size drawings for a toy model of the *Spirit of St. Louis*.

Simply by elaborating a little on the blueprint design and adding more details of the actual plane, Mr. Tanner raised his handiwork from the status of a toy into the scale-model class—a fine feat of craftsmanship, but one which any reader can duplicate with the aid of a little ingenuity.

The model is made almost entirely of wood and, of course, does not fly. Drawings for a flying model of the same famous plane are given in Blueprint No. 89.

A scale model of Lindbergh's *Spirit of St Louis* made by C. H. Tanner of Urbana, Ill.

Fan Converts Hot Attic into Livable Room

VENTILATING engineers say that the ordinary attic can be made livable for play or sleeping purposes, particularly during the summer months, by placing a comparatively inexpensive propeller type of ventilating fan in the gable end. The fan should be so arranged that it will draw out or exhaust the hot air during the daytime, but at night it is turned around so as to drive outside air into the attic space. The result is that the children not only have a play room but also may sleep there during the warm seasons.

It has been suggested by one ventilating expert that houses should be constructed so that each would have two or more flues leading from the basement to the attic, one to take the hot air from the attic to the cellar by means of a small fan, and the other to take the cold, damper air from the cellar to the attic. A fan would be needed in each flue.

Sharp Tools Save Time

FEW amateur woodworkers realize that minutes spent in keeping tools in working order mean hours of more effective work. A glint of light on the cutting edge of a tool tells the skilled workman that it should be sharpened on the oilstone, though it may not need to be ground. If an oilstone is used skillfully, it will seldom be necessary to grind a cutting tool unless it acquires a nicked edge.—C. A. K.

Portable Seat for Outdoor Events

Long waits at air spectacles and parades can be made less tiresome with these seats.

TO VIEW a parade or such an event as the arrival or departure of a famous aviator, it is often necessary to arrive an hour or two ahead of time. This entails a tiresome wait, especially if no seats are available.

What will add considerably to the comfort on such an occasion is a portable seat such as that illustrated. It is constructed of two pieces of board from a heavy box, a hinge, and a screw hook and eye. Provided the user's feet are spread well apart this seat is almost as solid as a three-legged stool.—LINCOLN LOTHROP.

Don't Chop Up That Table

(Continued from page 89)

The old hinge seats, however, must be patched all the way through, and, as a good job cannot be done where the grave for the patch is cut all the way through the board, these must be patched from both sides. The patch on the underside must come all the way to the edge of the board so as to renew the damaged part of the rule joint. On page 89 is shown a satisfactory method, the grave for the face patch being cut through to the hinge seat patch. The hinge seat patch is allowed to project out past the edge of the leaf or top. After the glue has set, trim the patch to conform to shape of the rule joint of which it is a part.

All patching completed, you now have new wood in which to cut new hinge seats. Apply new hinges and resurface the face of the work with sandpaper and fine steel wool. Oil the wood as you oiled the frame. The final finish will be discussed in a coming article.

A word of warning: Be sure that the top is not narrower than its original width or the leaves will stand out at an angle, giving the table a hoop-skirt appearance. This always can be avoided by inserting a strip of suitable width in the top before gluing the boards together, or, if this is not desired, by cutting back slightly the shoulders of the tenons on the end pieces of the apron.

This is the fourth of a series of articles on repairing old furniture. The fifth is scheduled for publication in an early issue.

Cabinets to Guard Your Tools

One Type Is for Saws Alone, Another Holds a Complete Kit
A Simple Way to Improve a Carpenter's Vise Other Kinks

NOTICING that my saws rusted when not in use, I made the case illustrated in Fig. 1. This is hung on the wall, and a dish of kerosene is kept in the bottom. I now find that my saws do not get rusty, no matter how long I leave them. Furthermore, the teeth are not exposed to accidental damage as when the saws are hung on nails in the open shop.

The box can be built of waste lumber ¾ in. thick. It is 12 in. deep, 14¾ in. wide, and 42 in. high. The saw holder is 12½ by 11 in. with slots 2¼ in. apart running with the grain. There should be a reinforcing cleat 4 by 12½ in. across the underside of the saw holder, at the back. The doors, too, should be well cleated to prevent warping, and hung with three hinges.

Finish the case with stain and varnish, or paint, as preferred.—FRED. E. FOX.

Fig. 1. The purpose of this cabinet is to protect a set of hand saws from rust and damage

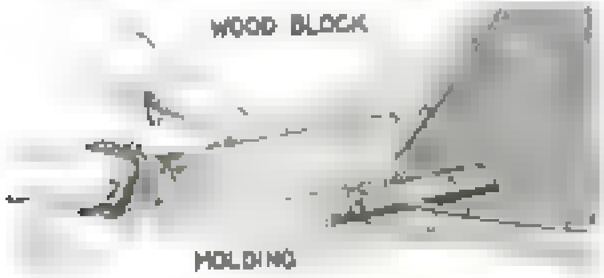


Fig. 4. A quick and easy way to miter screen molding with a single saw cut at each corner.

BOTH the tool-box and the bench-drawer method of storing tools have been tried by the writer, and, in his case at least, they proved inconvenient. The final and more satisfactory solution of this problem was the building of the cabinet illustrated in Fig. 2. It is placed against the wall over the workbench.

The tendency is to make cabinets of this type too small. There should be plenty of space for the addition of the new tools which are always acquired.

The stock used in this case was white pine: 2 pieces ¾ by 12 by 36 in. for the sides, 4 pieces ¾ by 12 by 34½ in. for the top, bottom and shelves, and 36 lineal feet of ⅜ by 3¼ in. tongue-and-grooved fir for the back. The doors, which are 18 by 36 in. each, are made of plywood panels like the cupboard doors ordinarily used on kitchen cabinets.

There are seven small drawers and one large drawer; all are 12 in. deep and fitted with flush ring drawer pulls.

The cabinet was stained with walnut penetrating wood dye, shellacked, rubbed with fine sandpaper, and given a coat of varnish.—E. G. LEVINE.

IN USING a wooden type of carpenter's bench vise, one is usually troubled more or less because the guide bar at the bottom sticks and requires adjustment from time to time according to the thickness of the work that is to be gripped in the vise.

This difficulty may be overcome and much time and trouble saved by the method illustrated in Fig. 3, which keeps the vise jaw vertical under all conditions. As the vise moves out, the chain passes over the two stationary pulleys on the bench leg and draws out the lower guide bar at an equal rate.—HOWARD DICK.

SCREEN molding can be mitered quickly and accurately by the very rapid and simple method illustrated in Fig. 4. The molding is cut longer than necessary and nailed in place except near the corners, which are lifted up far enough to allow a thin block to be slipped underneath. This protects the screening while a fine saw is used to miter both moldings at once.—M. S. T.

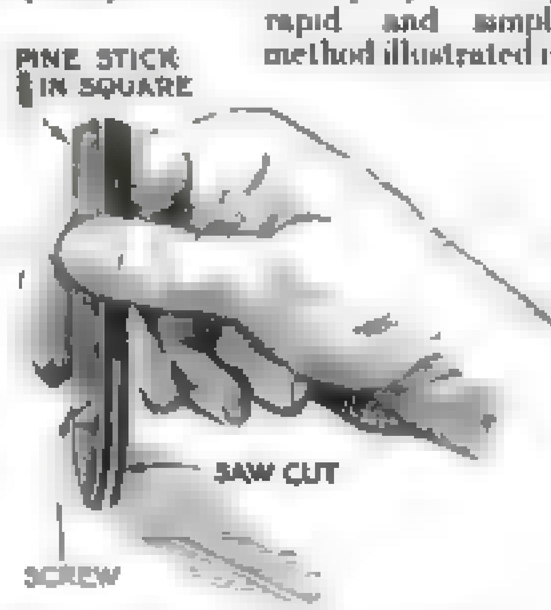
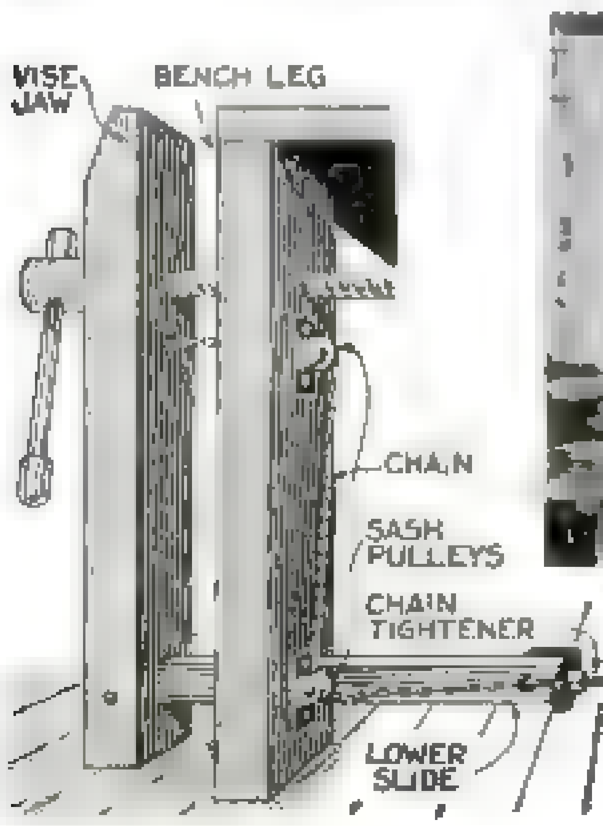


Fig. 5. A wooden tool like a draftsman's pen for applying stripes on painted furniture.

RECENTLY I wished to use fine stripes to give the finishing touch to a piece of furniture that had been painted with brushing lacquer. After I had tried several small brushes without success, I made a sort of ruling pen from a pine stick about ⅝ in. square, as shown in Fig. 5.

By using a small brush to fill the slot with brushing lacquer and by adjusting the width of the slot with the wood screw, I was able to draw fine, uniform stripes with the aid of either a straightedge or a curved form, as required.—N. M. BALDWIN.



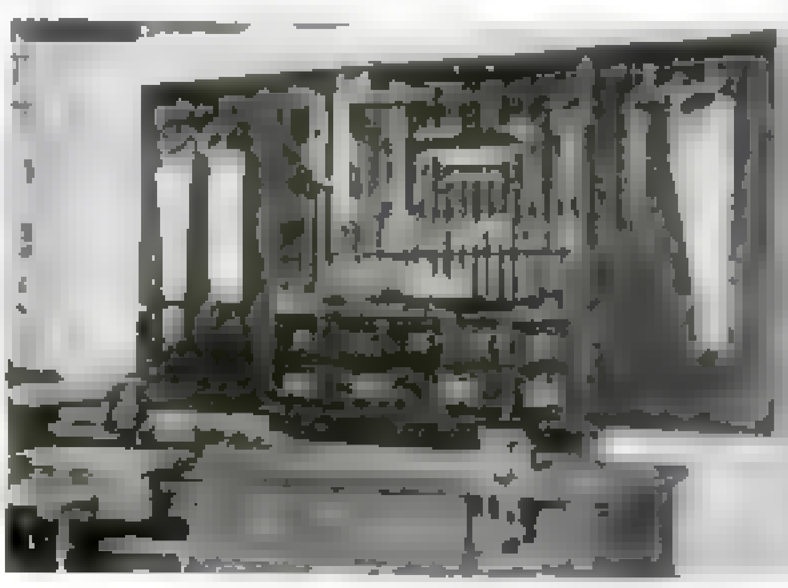


Fig. 2. An extra large tool cabinet designed to hang over a workbench. It has eight drawers for the smaller tools, miscellaneous supplies, and hardware.

Fig. 3 (at left). An ingenious automatic method of keeping the movable jaw of a carpenter's wooden vise always parallel with the bench leg or fixed jaw.

IN CELLAR workshops where light is at a premium, it is often possible to throw more illumination on the bench vise by hanging a mirror in such a position that it will reflect the light from a window

What Can Happen While You Wink Your Eye

(Continued from page 14)

thirty-two feet a second with each additional second that the fall lasts.

Some months ago a workman fell out of the fifteenth floor of a building in course of construction in New York City. On the thirteenth floor he grabbed a rope hanging from a scaffold and swung himself in on the twelfth floor, saving his life and astonishing himself, he afterwards confessed, as much as he astonished everybody who saw him. The explanation is, of course, that the fall of twenty or twenty-five feet before he grabbed the rope occupied about one second and a quarter, which was time enough for his thinking machinery to issue the orders which made his muscles take hold of the rope below at the proper instant. Had he been placed in equal danger while driving an automobile at sixty miles an hour he would have been killed.

MODERN life, with its speeding automobiles, railway trains, airplanes, and with its no less speedy machinery revolving in factories and homes, is pressing close on the abilities of mankind to react quickly and accurately. At the moment the chief danger is the existence of individuals whose reaction times are seriously longer than the average. An immediate improvement in the toll of highway accidents would be accomplished by denying drivers' licenses to such persons, a step already contemplated in some states and actually put into use by a number of business houses in hiring drivers.

As matters stand now, the United States lags in providing protection against dangerous drivers. Some states still require no licenses to drive. In others, the requirements are so easy that almost anyone can obtain permission to operate a car.

Germany, in contrast, demands a regular course of training in an automobile school, followed by driving practice in a double-control car, and a rigid test directed by a graduate engineer. The procedure of winning a license consumes eighteen days, instead of only a few hours.

As speeds increase, no remedy of drive tests or warning signals is likely to be of much use. To quicken the average reaction time of [mankind may be] possible by evolution in a million years or so, but is of no present help. Has science anything to propose except the legal limitation of all speeds within man's zone of safe reaction?

There is at least one possibility. Devices exist which are far speedier than the human nervous system. A photo-electric cell, for example, can react to a light signal in less than a ten-thousandth of a second. Perhaps speeding automobiles or aircraft could be equipped with these lightning-like electric eyes, so that collisions could be avoided and speeds checked automatically before the human pilot even had time for his tenth-of-a-second eye-wink, let alone for any kind of thought.

Identical Twins' Parallel Lives

IF YOUR family includes identical twins, should you count them as one person instead of two? Dr. J. M. Wolfsohn, of San Francisco, and Dr. S. A. Kinnear Wilson, of London, England, advanced the surprising theory that such twins, usually strikingly alike, are destined to run the same course of life.

A study of four sets of identical twins revealed that each pair suffered the same sort of diseases. One pair had diabetes at the age of fifty two, and both died of apoplexy at fifty nine.

Unlike fraternal twins, who are distinctly two different persons, identical twins have a single origin before birth.

Teaching "Lindy" Navigation

(Continued from page 54)

there, so that "0" at Greenwich swings over the top of your globe and reveals itself in the Pacific as "180."

A watch set to Greenwich apparent time shows how far the sun is from Greenwich. When a navigator observes the sun overhead five hours after Greenwich apparent noon he knows he is in longitude seventy-five degrees west. For such observations he uses a finely adjusted watch called a chronometer, which is set to Greenwich apparent sun time.

For night work he employs the same sextant that serves him by day, a record of the altitude curves of stars, and another chronometer which is set to Greenwich Sidereal time. Sidereal means "of the stars."

THERE has been a tendency on the part of some aerial pilots to scorn navigation. A few have scoffed at Commander Byrd's emphasis on the necessity for understanding navigation before risking transocean flights. Some have tried to silence arguments by referring to the uncanny accuracy of Lindbergh's dead reckoning. Most of them probably have believed that it would require years of mathematical study to learn navigation. For the man who is to direct a battleship fleet this is true. For the pilot of an airplane it is not. He may learn in a few weeks, even though his education stopped short of finishing high school.

A new word is going into the dictionaries before long to accentuate the difference. Instead of being called navigators, the men who find their position in the air by means of sun or stars will be called "avigators," and their branch of the science will be "avigation." Navigation was formed of the Latin words "navis," meaning ship and "agere," to move or direct. "Avis" means bird, and so we now have the word avigation just coming into use. An avigator will be anyone capable of finding his position in the air by means of radio, dead reckoning, piloting, or celestial navigation.

The National Advisory Committee for Aeronautics recently completed some studies which contain the essentials of "avigation." This is the knowledge Lindbergh is mastering. When he completes his studies under Commander Weems, he will be able to find his position at night in less than one minute. He will not need to know astronomy, logarithms, or any form of higher mathematics. He will "find himself" solely by observations of sextant altitude and watch time of two stars. The altitudes of a pair of stars are plotted as curves by this new method; and the point where those curve lines cross one another gives a direct reading of latitude. At the same time it reveals the amount of time that must be subtracted from the watch to determine the longitude. No correction to watch or sextant need to be calculated. With these star curves, a chronometer, and a bubble sextant, an avigator, flying above fogs and clouds, will be able to identify his position as often as he likes.

Before flyers began to test their wings in transocean flights, all they had in the way of navigational instruments were a map and a compass, often out of "whack" because of its proximity to the steel of the engine.

But when they began to fly out of sight of land they began to learn something about dead reckoning, that faculty by which mariners, blinded by fog or the failure of their navigational instruments, still keep some track of their progress.

A blind man counting the cracks in the cement paving blocks under his feet, keeping track of the street intersections he has crossed, is traveling by dead reckoning. If he forgets the number of streets crossed since leaving his starting point, he is lost until he asks someone to tell him where he is. Aviators, flying over the trackless ocean, unless they are navigators, are like blind men. Most pilots who have attempted transocean flights have not been navigators.

Mariners see in the appalling death list of these daring men and women a cause not apparent to most people. They believe some of those lives might have been saved if the lost flyers had understood navigation.

It was because naval officers are obliged to be navigators that Commander John Rodgers, flying in his PN 9 plane from California to Hawaii in September, 1925, was able to save the lives of himself and his crew, when forced down on the sea by lack of fuel. For ten days Rodgers and his men were accounted lost. But they were never lost. Using the same instruments he would have used if his craft had been a battleship, Commander Rodgers established his position. He was 300 miles from his destination. Sails were improvised and day after day he and his men worked nearer and nearer to the small tropical islands.

But when the Dole prize was offered as an inducement for aviators to make another try for a nonstop flight from California to Hawaii, many planes and many lives were lost. One, the *Golden Eagle*, is believed to have passed to the north of the Hawaiian Islands, and to have flown on and on over the ocean waste searching for the land they had failed to find by dead reckoning, until their fuel gave out.

Only a navigator could have performed the feat of Commander Byrd in flying to the Pole and return over a triangular course. Only a navigator could have been sure when he arrived at the North Pole. Wilkins was a navigator. So was Peary. They had to be.

CHAMBERLIN, flying with his passenger Levine from Long Island to Europe, was inexpert in navigation. He flew by dead reckoning, but it is significant that Chamberlin and Levine did not announce their destination. "Rome or Berlin" was all they would say in advance of their departure. That left them a wide margin of error, with still the prospect of a safe landing "somewhere in Europe."

As a typical example of what aviators flying by dead reckoning are up against, there is the case of the *Bremen* flyers, Koehl, Fitzmaurice, and Von Huenefeld, who were lost in the air when they sighted the lighthouse on Greenly Island. A savage storm had upset their calculations by dead reckoning. They knew they had reached land, but what land they did not know until they were told.

Lindbergh, Chamberlin, and Byrd, on their flights from America to Europe, were not bothered as much by compass variation as were the pilots of the flights from Europe to America. Unless taken into exact account, that variation would have mislead all of them into flying northward off their course into the almost uninhabited wilds of Labrador. Drift indicators, too, operate only where there is good visibility, and at least we know none of those westward flyers experienced good visibility. Everything tended to make their dead reckoning less exact than the marvelously efficient reckoning of Lindbergh.

This explains why aviators, yarning with one another about the tragic attempts to fly from Europe to America, wonder if some of the missing planes are not actually hidden in the wastes of Labrador. It is even possible, some of them believe, that North America actually received Nungesser and Coli and their *White Bird*, Hamilton, Minchin and the Princess Lowenstein-Wertheim, St. Roman and Mouneyres, Captain Hinchliffe and Miss Mackay. Once they lost track of their progress they were as lost as children who stray into the woods. Whether any of them are imprisoned in those Northern woods is a secret that may not be revealed to this generation.

Rockets Drive Amazing Auto

(Continued from page 20)

driven airplane able to rise high into the air, if not beyond it, is now the plan of Valier and his associates. Joined with the Opel Automobile Works in the new project is the Raab-Katzenstein Aircraft Works, German manufacturers of airplanes. Anton Raab, of this organization, is constructing the new rocket plane and proposes to be its first pilot.

In place of the usual airplane motor and propeller of the lightweight Raab sport plane christened the *Sparrow*, there will be one bank of steel-tube rockets. Two similar banks of rockets will be attached beneath the wings. The craft will be started from a special runway pointing steeply upward, much as fireworks rockets are fired from a supporting trough. Within two or three minutes after the first rockets are exploded the craft is expected to be eight or ten miles up, perhaps higher. Raab will be provided with bottles of oxygen, to breathe when the air gets too thin. It is expected that when his strange craft exhausts its rocket power and reaches its maximum height he can take charge of its controls and glide safely back to earth. A parachute may save him in an emergency.

A limited amount of steering would be possible, but Raab plans, for his first flights, merely to point the rocket craft in the desired direction. To avoid strains on pilot or mechanism by too sudden a start, some of the rockets will be fired only after the craft is well in the air, being touched off, as in the road car, by fuses which the pilot controls.

Long voyages in rocket craft, whether in air or out in the vacuum of space, would require some mechanism for recharging the rocket tubes. This has not yet been perfected, but there is small doubt that it can be. Arrangements to fire rocket charges from any part of the forward or rear ends of the craft would permit the car to be steered through space. To retard the car, if speed should become excessive, rockets could be fired from the forward end. The same device would probably permit safe landing on the moon or on any planet, even were no atmosphere available to support a parachute.

THE first flight, to be attempted soon, is no more than a preliminary step. What Opel, Valier, and the others really hope for are rocket aircraft capable of flying from Europe to America in an hour or two, traversing the levels of thin, almost nonresistant air eighty or ninety miles above the ground. Mails or passengers could be shot half around the globe in as many minutes as it now takes days.

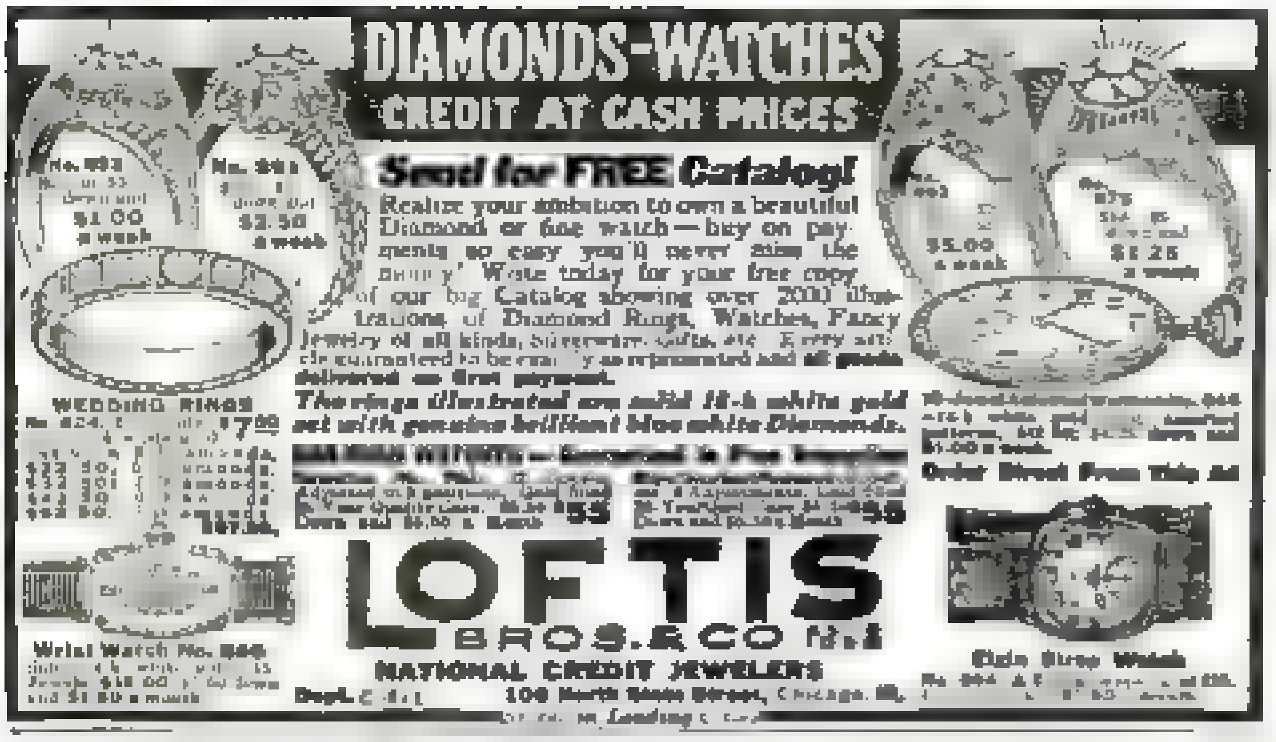
And, as the ultimate goal, there lies man's age-old dream of exploring space; of rocket craft carrying intrepid explorers to the dead, volcanic mountains of the moon; to Mars, perhaps the home of beings more intelligent than we; to the mysterious world of Venus of which astronomers catch no more than tantalizing glimpses through an occasional rent in that planet's veil of clouds.

Undoubtedly this dream of planetary voyaging has been brought a long step nearer reality than it ever was before.

U. S. Bands 270,000 Birds

NEW knowledge of birds' migration habits is being gained, and long-standing mysteries solved, through the banding and releasing of birds by the U. S. Biological Survey, according to F. C. Lincoln, in charge of the work. To date, 270,000 birds have been banded and 10,338 recovered.

Numbered identification tags are attached when the birds are released. Records are kept of a bird's location when set free and compared with reports of its recapture. Ducks furnish the most returns, probably because they are the most hunted.



A definite program for getting ahead financially will be found on page four of this issue.

Water Flivvering, New National Sport

(Continued from page 59)

Nelson, service station operators at Richmond Hills, near Seattle, Wash., journeyed a thousand miles to Ketchikan, Alaska, with two twin-cylindered outboard motors.

Edward G. Taylor, fishing editor of *The Chicago Daily News*, with a little outboard motor and a canoe, took camp equipment and a companion 500 miles against the swiftest currents flowing through northern Michigan and Wisconsin, often in the teeth of heavy winds on good sized lakes.

Such individual achievements increase interest and win many fans to the sport. The recently organized Birmingham, Ala., Motor Boat Club has affiliated with the Mississippi Valley Power Boat Association, and the outboard fans of Birmingham are holding regattas as well as cruising.

Walter Willman, of Illinois, all-round champion bait and fly caster, has contrived an outboard boat that he can operate with his feet, leaving both hands for casting.

MYRIADS of dual purpose tourists now use automobiles and carry on trailers small outboard boats with which to make brief excursions when the water looks inviting.

But these travelers are "pikers" compared with the scientists. Outboard motors were used effectively by the American Museum of Natural History's Greenland expedition in 1926. Commander MacMillan and Commander Richard Byrd have used them in the Arctic seas. Gregory Mason depended on them repeatedly when, as commander of the Mason-Spinden expedition to study remains of Maya civilization, he penetrated the jungles of Yucatan.

In racing, outboards have become almost as much in the public eye as airplanes, speed cars, or horses.

As in automobile racing, outboard boats are classified according to piston displacement. Some of the homemade ones are crude and curious; but all are in Class A if their outboards have less than fourteen cubic inches displacement; in Class B, between fourteen and twenty inches; Class C, between twenty and thirty inches.

SPECTATORS are thrilled by the antics of the bucking, kicking, plunging miniatures, but the navigators get much more fun. When twelve-year-old David Leonard nails a few planks together, names his nine-foot boat the *Black Cat*, and finds himself among *Cough Drop*, *Ouch*, *Whoozit*, and *Possum*, he's more excited than the five thousand fans at Winter Haven who witness the first regatta of the Florida Outboard Racing Association.

Never again may the Father of Waters see steamboat races in which darkies sit on safety valves, fire shooting from the stacks; but last year it saw the longest small-boat race ever held on inland waters. Seven outboards started from Chicago and, after threading the drainage canal between Chicago and Joliet, the Illinois-Michigan canal, and the Des Plaines, Illinois and Mississippi rivers, finished close together at New Orleans—a 1,750-mile battle with floods, driftwood, and machinery. *Miss Vicksburg*, the winner, averaged sixteen miles an hour, a record for a small boat at the distance.

But the outboards are taking to the high seas, too, as shown by the graphic story of the Catalina race in this magazine last April.

With the increase in outboards' numbers it becomes increasingly important that they shall be as well regulated on water as automobiles are on land. While sixty thousand Americans bought outboard motors last year, four times as many are in the market for them as this is written. They will soon be flivvering on our waterways.

Spare Parts You Should Carry

(Continued from page 76)

on what you can do," said Gus as his keen eyes studied the man.

"I can fix anything that rolls on wheels," he asserted with a confident grin.

"All right," Gus replied and pointed to Harbison's car. "Take the carburetor out and clean it."

Harbison started forward to protest, but Gus motioned him to watch what happened.

The wiry little mechanic opened his roll of tools on the running board of Harbison's car and Gus noted with satisfaction that the few tools it contained were high grade and in perfect shape. The man started the motor and tried in every way to make the carburetor misbehave, but he did not succeed.

"No job, chief," he said. "The carburetor isn't dirty, so there's no sense cleaning it. Got anything else?"

"HUMPH!" grunted Gus noncommittally. "All right, let it go. The party that owns that car is going on a long trip. Check over the tools and what spare parts he has and see if he needs anything."

The newcomer set to at once and Harbison turned to Gus, puzzled. "Why all the funny business with my car?" he asked.

"Keep your shirt on," advised Gus. "I've got an idea. This fellow is a wandering auto mechanic, but he's as neat as a pin and his own car appears to be mighty well kept.

"Meanwhile," Gus continued, "remember that the most frequent breakdown on the road is a puncture or a blow-out. If your tires are in good shape the chances are about a million to one you won't have more than a single flat tire at a time, and a five-minute tube vulcanizing outfit in the tool kit is handy after the day's run to fix the puncture or blowout.

"After the tires, the ignition system is where you have the most trouble. Ignition breakdowns are a cinch to fix once you find 'em—the trick is to find 'em. Anyway, you're carrying a spare coil and condenser, plus wire and spark plugs. You ought to be able to patch up most any breakdown at least enough to get to the nearest service station."

"There you go again," grumbled Harbison, "assuming that I've got a whole lot of mechanical ingenuity. I haven't. If I can't take along enough parts so I can just put in whatever breaks, I'll be out of luck and that's all there is to it." The wandering mechanic had by this time poked his nose into every compartment of Harbison's car.

"SAY, chief," he drawled, "the owner of that car don't need a thing. He's got everything but a tow rope."

"What do you say to that, Mr. Harbison?" asked Gus, turning to the wealthy motorist.

"I don't see that it proves anything," Harbison replied stubbornly. "Just because I've got enough parts and tools to suit a mechanic is no proof I've got enough for myself, considering that I'm not a mechanic."

"Then," said Gus, "why not add a mechanic, since that's what you need most?"

"Why—er—by George! I believe that's the answer," said Harbison, brightening. "Funny I didn't think of it before."

"Governor, you've hired a mechanic!" the stranger said, his black eyes snapping under their bushy brows. "Alec McGregor reporting for service! When do we start?"

Harbison looked at Gus uncertainly. "I'll vouch for him," laughed the latter. "He uses his head and he's honest. He finds out what's the matter before he starts to fix it and he doesn't fake jobs for himself."

"On that basis, you're hired, Alec," agreed Harbison. "Gus, I've a notion that's what you intended all along!"

Here Are Correct Answers to Questions on Page 65

1. In 1916 the United States purchased as a protection to the Panama Canal the right of way for one through Nicaragua with the rights to naval bases at the western and eastern terminals.

2. The animal that yields chinchilla is an inhabitant of the high Andes Mountains of South America, chiefly in Peru and Bolivia. It is a squirrel-like animal, usually less than a foot long.

3. Chocolate is produced from the fruit of the cacao bush, native to tropical America, now cultivated in many other parts of the world. Most of the present commercial supply comes from the West Indies and the northern coast of South America.

4. This is a provision of the laws of the republic of Czecho-Slovakia.

5. In the Province of Quebec, eastern Canada, including the cities of Quebec and Montreal. This part of Canada was settled originally by French colonists and passed into English control only at the time of the Napoleonic Wars. English-speaking travelers find it easier to get along in France itself than in parts of this province.

6. Two well-known lakes possess this distinction—the Dead Sea in Palestine and the Great Salt Lake of Utah. Both are so salty that the body will not sink in them.

7. It is believed that this is the railway bridge that crosses the gorge of the Zambezi just below the famous Victoria Falls in South Africa. It has the tremendous height of 400 feet above the water.

8. The kimono is a slightly modified form of the ceremonial dress formerly worn by people in Japan. In modern years the Japanese and Chinese men increasingly are adopting the familiar coat and trousers of western countries.

9. This is not a jackass at all, but a species of bird that lives in Australia. It makes curious noises, very much like the chuckling and laughter of a man. Many travelers have mistaken it for some person hidden within earshot.

10. The whirling dervishes are found all through Spain, Palestine, and northern Arabia, as well as in northern Africa. They belong to a special sect of Mohammedans whose religious exercises include their whirling dances.

11. Opposite the south porch of the White House, in Washington, D.C., there is a stone monument erected by the United States Government. This is used as the official center for land measurements all over the country.

12. A proposed system tying together all the electric power plants in the Eastern United States by means of electric transmission lines. Many of these lines have been installed already. When the system has been completed, the great water-power producing points, such as Niagara Falls and the steam-power plants at the coal mines, all will be connected so that power produced anywhere can be used anywhere.

Onward Strides of Science

(Continued from page 60)

with the chemicals ordinarily found in natural soil which plants require for food. The wheat grew at an unheard-of pace, reaching maturity in thirteen weeks instead of the usual five months.

In the laboratories of the U. S. Bureau of Standards at Washington, D. C., experts recently set up apparatus which not only produces sunshine, but all sorts of weather as well. It is used to make rapid tests of the durability of paints, varnishes, enamels, and lacquers, which are in turn exposed to hot "sunshine" produced by a carbon arc, a "rainstorm" created by a water spray and "the ravages of time" in the form of ionized air—that is, air containing oxygen in very active form. Thus the materials quickly get the equivalent of several years' wear.

If scientists can learn how to control the weather as successfully as they now duplicate it, baseball games no longer will be "called on account of rain" and trans-Atlantic flyers will have little to worry about.

Hunting Lost Races of Men

EXPLORERS, following the dim trails of lost men, are unfolding some of the most thrilling mystery stories ever told.

German, Austrian, and Russian scientists are climbing to the "roof of the world" in the Himalaya Mountains of Russian Turkestan in search of a lost race of white men believed to have been marooned for centuries on the desolate peaks. These Robinson Crusoes are thought to be remnants of a people who fled when the yellow-skinned Mongols swooped down on Asia in the Middle Ages, but who originally lived in India and Europe. Today they are isolated in the heart of Asia, in a wild region never before explored by Europeans.

In the middle of the Pacific ocean, off the coast of Peru, is a mysterious dot of volcanic land called Easter Island. No men live there now, yet on its soil have been found ruins of vast buildings, statues, and other signs of a once prosperous civilization. Dr. J. Thoulet, French oceanographer, who has just completed a study of this desolate spot, reports the island is the tip of a mountain peak—all that is left of a once thriving island continent, like the fabled lost Atlantis, which sank beneath the waves ages ago. This highest peak, he believes, was the site of a temple of a race which was swallowed by the sea in one of the world's most frightful tragedies.

Most Daring North Pole Plan

THE one regret expressed by Capt. George H. Wilkins at the completion of his astonishing airplane flight across the Polar Sea was that he dared not chance a landing on the rough ice to make soundings and observe ocean currents. Such observations are necessary, he conceded, before the true nature of the Arctic, and its influence on the rest of the world, can be understood.

To accomplish this, an adventure which would call for unequaled daring has just been proposed by an experienced Polar explorer, Dr. H. U. Sverdrup of the Geophysical Institute of Bergen, Norway. He would take a party of scientists north in an airplane and land them on a floating ice cake near the North Pole. There, drifting about at the mercy of the elements, they would live for a year or two as exiles, making records and observations. Eventually an airplane would return to pick them up, being guided by radio to the spot where they had drifted.

Of course, if the cake of ice should break up or buckle under the tremendous pressure of the Polar pack, the explorers would face almost certain death.

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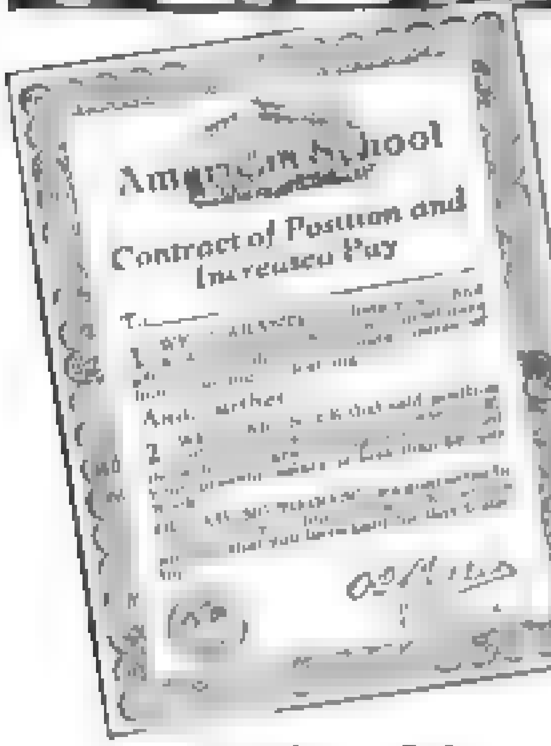

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Timing the Speed of a Bird

So successful was the experiment that Col Meinertzhagen continued his observations with other birds. A swift leisurely circled his plane one day when the indicator showed a speed of sixty-eight miles an hour; the bird must have been making a hundred at least Geese and ducks the flyer passed, in calm air, at nearly a mile a minute; lapwings and curlews were as easily outdistanced.

That the birds reputation as high flyers was a mistaken notion was another interesting fact the airplane disclosed. Several hundred available records of heights at which airplane pilots have sighted birds show that a mile high is exceptional, and even the longest of migratory flights are generally made at three thousand feet or less. Only once—and that was over the battlefields of France, where the roar of cannons had probably frightened them to great heights a flock of small birds of undulating flight was sighted two miles high. Completely exploded was the myth that birds attain tremendous velocities by escaping from our atmosphere into the thin air above.

But some of them are fast enough. By checking with stop watches the flight of birds over measured fields, observers corroborated the estimates of automobile and airplane observers—and established the swallows and the swifts as the speed kings of the feathered tribe. In India, E. C. Stuart-Baker timed swifts over a two-mile course with stop watches, and found that they were able to cover the distance regularly in thirty-six to forty seconds a maximum speed of two hundred miles an hour or three and a third miles a minute

On another measured field, three hundred feet long, a robin was timed at thirty miles an hour and a snow bunting at thirty-one A domestic pigeon made thirty-four miles an hour and a crow slower than some of his fellows, thirty-six

FASTEST of all point-to-point distance records made by birds was a swallow's in a European race with three carrier pigeons. The swallow taken from her nest under the eaves of a house in Antwerp, Belgium, was released with the pigeons at Compiegne, 148 miles away Watchers were notified by telegraph of the start In exactly one hour and eight minutes the swallow was back on her nest She had made almost 135 miles an hour, setting an official world's record Three hours later the first of the pigeons came in, averaging about thirty-five miles an hour Its pace had evidently been leisurely, for pigeons in other races have done far better

Runner-up in bird speed contests is the wild duck On one occasion a point-to-point flight of a flock of ducks was checked by telegraph They were found to be speeding at ninety miles an hour a mile and a half a minute

These are the observations by which we have recently learned, for the first time, how fast birds really do fly Think of the difference between the flying ability of the swifts, with their light bodies and thin, powerful wings, and the little goldfinches that in comparison seem actually clumsy—as much difference as there is between a speeding express train and a man walking along the road beside the tracks. But the swifts and swallows can leave the express train far behind, we know now. They are among the fastest things on earth

Bolt Turns Corners

A BOLT that can go around a corner is a structural novelty developed by a cable-making concern, which claims for its flexible shaft unique advantages in industry. It can double up in a U-shape to serve as a hanger for pipe; other uses are practically unlimited in bolting machinery parts and shackling temporary wall fittings.

DICK BYRD—Adventurer

(Continued from page 58)

between conflicting views of his friends, his backer, the public, and his conscience.

Then bad weather set in for two weeks. But at one A.M. on June 29, 1927, Dr. Kimball of the New York Weather Bureau telephoned to Byrd at the Garden City Hotel that conditions were favorable, though not ideal. Dick had had only one hour's sleep but he rose and dressed. He roused his mechanics and his fellow flyers, Balchen, Acosta, and Noville. (Balchen, the Norwegian pilot, had been on the North Pole trip, and was selected for his ability to replace Floyd Bennett, who was still on crutches.)

The morning was dismal. A drizzle obscured the flat Long Island landscape. The runway was heavy, dangerously so to get the load of 15,000 pounds into the air.

SLOWLY the huge Wright Whirlwind engines were warmed up. Bert Acosta took the controls, Byrd by his side. Balchen took station near the radio. Noville crouched by the main tank dump valve, to let go all the fuel in case of a crash and save the party from being burned to death.

Acosta shot his gas wide open. Tom Mulroy, who had been engineer of the *Chantier*, stood by to cut the lines that held the *America*. But the big ship broke free of her own accord.

Across the heavy field she lumbered, her massive wing dipping as she lurched this way and that. The crowd held its breath. Once Acosta raised his hand for Noville to dump. But just before it was too late the wheels left the ground.

The huge ship circled above the field and disappeared into the low-hanging clouds.

The other day Dick Byrd showed me his water-stained log of the trip, and I copied a note made soon after his take-off:

"Raining, fog, clouds low, standard compass 85½° wind southwest on surface, drift 5° right, air speed 100 miles an hour, altitude 3,000 feet."

The last land was seen near Halifax soon after midday. This was bad. An accurate "departure," as the navigator calls it, is very important to a long ocean traverse. But Newfoundland was blanketed with fog when by "dead reckoning" the plane reached its vicinity. With heavy heart Byrd ordered a course change eastward, praying that his compass would keep him straight.

"PLEASE check fuel," Byrd scribbled on a piece of paper at two P.M. and handed it to Noville. Talking was out of the question with the roaring of the three motors.

Noville emptied the last of the extra cans that had been taken in the body of the machine because the tanks would not hold quite enough, and set about checking up. His look was glum as he handed his result to Byrd.

The consumption had been higher than anticipated. *At the rate the America was gulping fuel she would fall into the sea for lack of it before reaching Europe.*

"Shall we go on?" Byrd asked the others. He felt himself responsible for the lives of those with him. It was not fair to them to keep them in the dark about this new peril.

"If you wish, Commander," was the gist of every reply.

As it turned out, Noville's figures were in error, yet for many hours all four men sailed on believing their chance of reaching the other side was very thin.

Another aspect of this fuel problem was that Byrd had insisted on taking 800 pounds of dispensable scientific equipment in order to get the fullest possible scientific results from the flight. He figured—rightly as it turned out—that he could take plenty of fuel to reach Paris, but he sacrificed for the sake of science the extra gallons that would have kept him in the air over France until daylight.

So, from Newfoundland on, Byrd kept reporting conditions and exchanging weather reports by radio with the Federal stations behind him. Once he sent congratulations to Maitland winging his way from San Francisco to Honolulu. The Army flyer actually got the message, the first of its kind in history.

Through the blinding fog and darkness the *America* roared her way. Noville discovered his first fuel figures were incorrect; but the pleasure of the discovery was ruined by finding a dangerous leak in the main gas tank.

Wrote Byrd: "I was going over again the same sort of time we had had over the Polar Ocean from a bad oil leak, only this time I had the responsibility of three men's lives instead of one."

By use of a patent putty the leak was finally stopped some hours later.

Dawn came with a pallorlike death through the vapor masses that hemmed in the plane. No water, no land, no sky to cheer the four tired flyers. A high altitude was kept for safety. The altimeter reads only the difference in atmospheric pressure between that at the surface and that where the plane is. There was no way of knowing the surface pressure here.

"Why not radio a ship and compare barometers?" the reader may ask.

The answer is that since the ship could not see the plane and since the flyers could know their position only by rough dead reckoning, such a comparison might lead to an error greater than ever.

ON THE afternoon of the second day the fog thinned and the cloud masses below the plane broke just as she was passing over land. Byrd recognized Cape Finisterre, on the Northwestern tip of Spain, below. By a miracle of skill he had navigated nearly twenty-four hours by dead reckoning alone. In the worst possible weather conditions, he had flown blind all the way from Halifax to Finisterre.

Soon after dark Byrd saw the lights of Paris. But rain had set in, bringing a thick mist with it. To land would have endangered those on the field as well as those in the plane. As she circled, the night grew thicker.

"We heard you flying above us at Le Bourget," said the great French poets, Le Brix and Costes, when they visited America this spring. "And our hearts went out to you because we knew your helplessness."

Then the compasses went out. It was a crisis in the flight such as no man had been called upon before to face. The chance that any of those aboard would ever come out alive was not one in a thousand. Fuel was low. A forced landing on the land would have wrecked the plane and killed all hands.

Surely the Almighty took a hand at this point. For, with naught else to guide her, the plane providentially circled back to the coast.

"A decision had to be made," said Byrd. "My big job now was to try not to kill any one beneath us and to save my shipmates."

He dropped flares when he saw a glimpse of the water, and circled down toward them.

These flares, another indication of Byrd's thoroughness in preparation, saved four lives that night.

The story of the landing at Ver-sur-Mer has been retold many times. The plane was wrecked. Four exhausted men swam ashore, were taken for tramps by country folk on the dark road, and finally received by the hospitable lighthouse keeper. Paris gave another great welcome.

Again New York brought out the fireboats and the bands, the "Broadway Blizzard." But through it all Byrd's eyes were now and then tinged with sadness. (Continued on page 128)

DICK BYRD—Adventurer

(Continued from page 107)

"Anything wrong?" I asked him when I had a chance

"I can't help feeling Floyd Bennett ought to be a part of this," he said, then added, "but there is still the South Pole

Little did either of us think that Floyd Bennett's body would lie in Arlington beside Peary's only ten months later

• • •

Dick Byrd is now planning his trip to the South Pole. He will go to the great Antarctic continent this autumn, establish a base, and fly southward over that vast unknown territory.

Surely this is the most dangerous thing Byrd will ever attempt. Had he crashed on the Polar Sea he could have walked back to dry land. He would have had a fair chance of shooting bear or seal or birds. He would have found caribou and musk oxen ranging the hills behind which the Eskimos live.

None of these exist in the dead wilderness that surrounds the South Pole. No animals or Eskimos, practically no dry land, save here and there where a few narrow rocky strips creep out from under the sea.

But there is great incentive. There is no telling what Byrd may see from his plane. He may find new land, volcanoes may spout smoke and flame as he passes over them. It is conceivable that some strange animals or birds or even human beings may be found in the center of that vast white desert.

But whatever befalls him, Dick Byrd will meet it with the same quiet courage and swift resource with which he has met the other crises in his adventurous life.

Next month—the hitherto untold story of Commander Byrd's remarkable preparations for his forthcoming dash to the South Pole. You won't want to miss this absorbing account of one of history's greatest ventures in exploration, told by Byrd's lifelong friend and fellow naval officer.

Fortunes from Magic Logs

(Continued from page 41)

sand tons or so a year mostly for spirit levels and other instruments which require wood that will not warp even slightly

"Some of the other woods are important because of their dye-giving properties. Logwood is one of these. For centuries it was the only thing known that would give a satisfactory black dye for woolens. It's scarce now, though an occasional shipment comes from Dutch Guiana. However, it is not missed because chemical dyes have been found to supplant it. But nothing has been discovered to take the place of Brazil wood and fustic. The first gives the brilliant hue to a fireman's red shirt and the second yields khaki-colored dye for military uniforms." Mell next led me to a small pile of squared dark brown timbers of very close-grained texture. "This," he said, "is Hawaiian koa wood, used in this country exclusively for making ukuleles. It is most expensive of all and next is this snakewood, from Dutch Guiana."

THE deep red base color of snakewood is mottled with lighter, yellowish-red markings which suggest some strange alphabet and sometimes take actual alphabetical forms. "In the wholesale trade we know this as 'letter-wood,'" said Mell, "but in canes and umbrella handles it becomes snakewood."

The revival of archery has brought about renewed activity (Continued on page 125.

A definite program for getting ahead financially will be found on page four of this issue.

Fortunes from Magic Logs

is the market for alcoque, a light-brown hard wood from Dutch Guiana which holds glue well, and so is in demand for the "footings" or points of arrows. The best of all bow woods is the English yew, which is getting scarce and expensive. American hickory is also used, and also the Osage orange of the Southwest—called by the French voyageurs "Bois d'Arc." But the choice of archers is now lancewood, from Jamaica, which is incredibly tough and springy; lemonwood from Cuba, or greenheart from British Guiana. Lemonwood is also called "degame" when used for fishing rods.

A beautiful wood with similar tough springiness is Pernambuco, from Brazil, used in making violin bows. Other musical instruments are also dependent upon strange woods from far-off places. Clarinets are made from Grenadilla wood, brought from Mozambique, Africa. A very fine rosewood, from Honduras, is used exclusively for making xylophones. When struck, a piece of seasoned rosewood gives a clear musical tone.

OUT of Africa comes ebony, used for black piano keys and the inlaid stripe around the edges of a violin. "We get that wood in irregular spurts," Mell said. "When palm oil is plentiful, ebony is neglected, for the oil pays a higher wage to the negro."

He pointed to a varicolored pile of planks and explained that it contained a dozen strange timbers from as many lands. They included amaranth, a beautiful purple wood from Dutch Guiana, used in fancy inlay work on furniture; lacewood, from Australia, with a texture like fine lacework; yellowish-white satinwood, from Ceylon, which has been used for years for making jewel caskets.

Near by, we sat down on a great timber of English brown oak. On one side, a century-and-a-half-old inscription was still visible, reading "Rob't Chapman Miller, 1778." I asked Mell to tell me some of his experiences in junketing about the world, searching for rare timber in places that are only romantic names to most of us.

"It is interesting work, all right—this hunting for rare trees," he said, "and I suppose there is romance and adventure there, too. But when you are in the middle of it, you don't see the adventure element. You are too busy fighting the insects and avoiding sunstroke!

"But there are certain thrilling moments that stick in your mind and come back to you, such as when you see for the first time an entirely new kind of wood, or when, as I did in Dutch Guiana, you first lay eyes on a commercial supply of wood which has lain unknown and has never been introduced into the world's market. I had been searching for weeks that time along the Guiana coast during the rainy season, plowing through water up to my waist, when I stumbled upon this horde of rare timber in an unmapped region.

"At another time, down in Mexico, I found a cache of cypress logs where they had remained since the days of the first Spaniards who cut them under the banner of Cortez and his conquering soldiers. They had been chopped down to make a fort in 1515, and for generations they had lain waterlogged and buried in silt at the foot of the rapids of Paso Lagarto. They were as solid as when first cut, and some future generation may mine those ancient logs for use at a remote date and find them as sound as they are today!"

The newspapers recently published the statement that in the last thirty years the list of known trees has been increased from 601 to 1,177. Behind that simple statement lies a world of high adventure in which Mell and Cooper and their brother rare wood hunters have played the leading rôles.

The Weakling

Continued from page 81

Chief," he had said, "you won't mind carving my initials on a bench, or somewhere, will you? Just to show that I belonged to the service?"

Anxiously the chief and one of the boatmen spread the big loop and stood with arms extended. To make it possible for the Weakling to locate the loop, the men had touched off a red fuse.

The roar of a motor cut into the thunder of the surf. He's got her started!

But if the chief could have witnessed the Weakling's superhuman struggle just then, as he frantically tried to get the big ship into the air in the gale, his renewed hope would have been short lived. Luckily, though, the field adjoining the hangar was smooth, and blown nearly clear of snow.

With the big plane once out on the level field, the Weakling tied his iron bar to the end of a fifty-foot line, and with one end of the coiled rope securely fastened to a strut, he placed the bar on the floor of the cockpit.

AT HIS direction the blocks were kicked aside from the wheels. Jack Rivers adjusted the helmet that he'd found in the cockpit; a pair of goggles would have been a godsend, but there were none. He pulled the frayed collar of his raincoat tighter about his throat. As the men leaped clear of the wings, he opened the throttle wide and swept the big ship full into the teeth of the gale. Gingerly he pushed forward on the stick; it was hard to figure in that wind. She responded instantly—almost too much! The nose went down, and with a wrench on the stick he saved her from plunging to earth. The wheels bumped, rose to the air, then bumped again, with one wing at a dangerous angle.

Again he gave her the gas, and this time managed to lift her clear. In a wide circle he zoomed for altitude to get above the storm. Suddenly a swirl of wind caught the big ship and almost flung it out of control. The iron bar had plunged downward, and its dragging weight made a serious problem for the pilot. He glanced at the altimeter. Five hundred feet. That was too high to pick up the life line. Below him a swirling mass of clouds and snow blotted out all landmarks. He'd lost all sense of direction. But anyhow he'd have to go lower. Suddenly through the white screen he spied a red light, then a flashing glimpse of the band of men on the beach.

"There he comes! He's made it!" cried the chief.

To the ears of the weary men came the drone of the airplane motor. It grew louder, then like a huge gull, the plane swooped toward them.

WITH wings almost touching the two men holding the loop, it roared between them, and the life line was jerked from their numbed hands. As the machine swept out over the water it was caught by another furious gust of wind. One wing dipped almost to the crests of the waves. The chief groaned. But somehow the Weakling righted her. Another second and he lifted her and roared to safer altitude. In the flare of the steamer's red lights the men on shore watched the flyer's thrilling battle against the elements.

Once more the plane swerved crazily, and for a moment it seemed that the Weakling had lost control. Almost into the surging sea, he lifted her, and this time swept directly over the steamer. He leaned out over the fuselage and hacked the rope in two. Another instant and they saw eager hands clutching at the life line on the ship's deck. He'd made it!

Quickly the heavier tackle and rescue cable were attached to the life line and hauled to the steamer. The life car was quickly attached. A few more anxious moments and the first load of rescued men and women were huddled on shore.

None would ever forget that wild trip above mountainous waves. As the life car made its last trip ashore with the captain and five members of the crew, the rescue cable jerked; the red lights on the steamer's upper deck went suddenly dark. The ship had sunk!

Chief Macfarland stood soberly in the headquarters building, one great arm about his wife, the other clasping his daughter. He was telling Captain Bruce how the brave air pilot had risked his life to save them all.

"An' now he's out there somewhere, beyond the help of any of us. An' to think, Captain," he groaned, "I named him 'Weakling.' Think of it—and he showed us he was the only man here that could do the job!"

Captain Bruce touched the chief on the shoulder. "I could have told you a few things about Jack Rivers," he said. "My son flew with him, over across. Bravest kid that ever held a stick, they say. If he can only make it to get back! I'm afraid he hasn't got a chance, though. Wind's swung 'round off shore—"

IF THEY could have looked out over that turbulent sea, they would have seen Jack Rivers desperately fighting to lift the biplane to safer altitude. He had barely cut loose the life line over the sinking steamer when he'd been caught in a whirling volcano of sleet and wind. Minutes turned to an hour as he fiercely struggled to get above the storm. He knew that he'd saved the ship, he didn't want any praise—he'd never looked for that sort of thing—but somehow it would mean a whole lot just now, if he could get back to the Coast Guard headquarters, and just be one of the boys. If only it wasn't so cold!

The thin raincoat had been poor enough shelter on the beach and above the waves, but now in the higher altitude it was no protection at all. The biting wind cut through him, his hands were numb; his feet were like wood. As he leaned toward the altimeter, he realized to his horror that his eyes were failing him. The instruments were useless.

THEN it was that Jack Rivers' flying instinct born of training in the Air Service in France came to his aid. "I'll fly it blind and make it," he told himself. "I've got to do it."

He must go down. Somewhere below a band of men were watching for him. Clumsily he managed to push his left foot against the rudder bar. He couldn't feel it move, but somehow he had a feeling that it was probably doing something. Then he tried to push the stick forward. His hands wouldn't move—or did they? Yes—dimly he realized the plane was going down. But how would he land?

As he dove swiftly, some instinctive force guided the numbed feet and senseless fingers. Then across his blurred vision appeared dimly a red light. That meant home.

* * *

Through the windows of the Coast Guard headquarters men and women peered into the night, watching, hoping against hope. Suddenly the chief started. That heavy drone wasn't made by the surf! With a bound he reached the door.

"Come out!" he shouted. "The kid's made it. He's overhead."

Red lights illumined the beach as men and women rushed out into the storm. An airplane motor was roaring into the teeth of the gale. A big snow-covered object, with battered wings and clusters of icicles hanging grotesquely from its underbody, swooped from the clouds. A crash, and all was ominously quiet. The chief rushed forward.

In the midst of a shapeless mass of wood and canvas sat the Weakling. Stiff, ice-coated, his eyes closed, face white with frost, he moved feebly as he heard the chief's voice.

"I cracked up again, Chief," he shivered. "Got a cigarette handy? I l-o-s-t mine—"

If a Boxer Should Hit You

fection of little shock absorbers which Nature has distributed throughout the body. The finely-strung mechanism of our bodies consists of a frame or "chassis" of jointed bones actuated by the muscles through moving tendons. In cavities in the joints, between muscles and tendons—in fact, between all moving parts where friction might develop—are placed little pouches or sacs containing a lubricating fluid called "synovia." These serve as shock absorbers. Their condition determines the resiliency of the boxer's body in absorbing not only the shock of being hit, but that of hitting. They determine his ability to "travel" with or from a blow without apparently moving from his position. And just as there are bumps in the road which an automobile shock absorber cannot offset, so there are blows in the ring which are too much for the human shock absorbers. Then comes the knockdown.

In the average bout in which there is no knockout the quality of the shock absorbing mechanism in large measure determines the outcome. Often the man who does most of the hitting tires as fast as his opponent who takes the most punishment. Jack Delaney and Paul Berlenbach are examples who may be said to have been worn out as much by the punches they gave as those they took.

AN AVERAGE man, with no better than average shock absorbing mechanism, could hardly hope to endure more than a single blow from a champion. Moreover, he might about as well drive his fist against a stone wall as to accept a pugilist's invitation to "hit me in the stomach and see if you can hurt me." In either case it is Mr. Average Man who will be hurt.

But natural toughness alone is not enough to make a champion. He must preserve this inherent quality by careful living; he must develop it to the highest degree by scientific training, and, of vital importance, he must acquire physical speed, quick thinking, and skill in boxing science. Almost every champion of modern times has emphasized clean living as the first essential. Irregular or evil habits that interfere with the body's smooth-running mechanism almost always have proved disastrous in the end.

As for training, the programs of different boxers to "condition" themselves vary largely according to individual needs. For the "toughening" process we find many, like Dempsey, retreating to the backwoods to labor and play under conditions as primitive as possible. For his fight with Tom Heeney in defense of the heavyweight title, Tunney spent preliminary months under Florida sunshine, punching bags, skipping rope, playing golf, and swimming. The fighter cannot afford to let himself grow soft. It has often been asserted that three years of easy living lost Jack Dempsey his title.

WITH top-notch physical condition assured, next on the program is intensive training, including daily "road work," and workouts with the bag and with sparring partners.

The chief purposes of road work are to improve the wind and strengthen the legs. Fighters differ on how it should be done. Tunney, for example, insists on running over hilly rugged country, while Tommy Loughran maintains that running does a fighter no good, but that walking is excellent.

It's an old sporting adage that "a boxer is as old as his legs." For some reason, a boxer's legs seem to fail him earlier in life than, say, a baseball player's, although most boxers do more road training and travel less on their feet in actual contests than does a Ty Cobb.

The answer may be found in an old account of Thomas Sayers, British champion from 1828 to 1865: "His foot- (Continued on page 156)

If a Boxer Should Hit You

(Continued from page 48)

work was brilliant. For where a ballplayer uses his legs mostly for running, a boxer is constantly rocking, side-stepping and balancing. That calls for virtually the same strength and flexibility of muscles that a ballet dancer has, and few dancers last far into the thirties.

When two finely conditioned fighters meet, the outcome is likely to be decided by the ability of one to reach one of the few particularly vulnerable spots of his opponent's body.

Of these the most likely spots for a knockout, as we know, are on either side of the point of the jaw, and the solar plexus. A well-directed blow on the "button" momentarily paralyzes the nerve centers of the brain, producing unconsciousness. A lifting blow on the solar plexus has a benumbing effect on the heart, and momentarily paralyzes the lower limbs.

One solid punch to either of these vital spots is enough to fell the average man. A first-class fighter, however, can shake off the effects of many hard punches to the jaw. It takes a swift succession of them to bring him down. Some boxers are known to have a fragile or "glass jaw." They don't last long.

The early minutes of a fight are particularly dangerous, for then the body has not yet had time to warm up, and all sensitive points are particularly vulnerable. That is why most boxers proceed cautiously in the first round. It is in this "cold" period that most of the one-punch knockouts are scored.

One of the most spectacular of these occurred in the recent heavyweight fight between Jack Delaney and Sully Montgomery. Before the end of the first minute of the first round, Delaney caught his far heavier opponent flush on the jaw and laid him out for the count.

STRANGE to say, despite the peril of the solar plexus punch, knockout blows of this kind have been extremely rare, although fighters everlastingly pound each other on the stomach. I can think of only one great fight won by such a punch. That was when Bob Fitzsimmons stopped Jim Corbett in Carson City. Many a good man, though, has had his strength so sapped by punishment on the stomach that he has become an easy target for a knockout.

Professor O. Hering, of the University of Cologne, an eminent European physiologist who has been investigating the mystery of the knockout, recently found that the carotid arteries, which lie along the upper part of the neck and the sides of the jaw, are other particularly vulnerable points. They are the arteries which carry the blood to the head. A hard "carotid" punch, he says, will produce unconsciousness.

Science still has much to learn about the essentials that go to make a successful boxer, and about the parts of his body he must defend most carefully. One can say that a heavyweight fighter should weigh so much and be built in such and such proportions, but always there will be exceptions. Who can explain how the amazing, lanky Bob Fitzsimmons could carry a deadly knockout wallop in either hand, and could stand up to the best of the giants?

Again, many a fight has been won by a "freak" punch, unclassified in the boxer's lexicon. Tunney once scored a knockout against K. O. Sullivan with a clean blow between the eyes. Back in 1891 the Nonpareil Jack Dempsey knocked out Jack Heglan by pounding him on the hip. And Jim Jeffries with a terrific left to the ribs dropped Jim Corbett for the count.

Finally, when it comes to picking the surroundings suitable for the rearing of a great fighter, we find that environment—"tough" surroundings or whatnot—apparently has nothing at all to do with it. Jim Corbett was a bank clerk, Tunney was a shipping clerk. It is entirely possible that you have the makings of a champion and do not know it.

Buying a Loudspeaker—

(Continued from page 47)

fed into it Furthermore, it must do this with equal effectiveness no matter what the frequency, and, in addition, it must not be guilty of harmonic distortion. In other words, it must not convert an electrical vibration at one frequency into a number of air vibrations having a different rate. Many of the highest grades of loudspeakers are capable of a very fair approximation of ideal reproduction. Some of the cheap, low-grade speakers do not come within speaking distance of it

The principle obstacle to perfect reproduction lies in the fact that virtually every physical object has a strong tendency to vibrate at some one particular frequency. You know, of course, how a violin string starts to vibrate when the bow is drawn across it and that the rate of vibration, or, in other words, the musical note it produces, is just the same no matter how fast or how slow the movement of the bow The only way you can change the musical note is to tighten the tension on the string or change its effective length with your finger

STRIKE a tin pan with a wooden stick, tap your water glass with your knife, or drop an iron rod on hard pavement. In each case you set the object into vibration at its characteristic rate and you get a sound that is duplicated each time the experiment is repeated

In the construction of the loudspeaker, the armature on which the magnets act, the spring that holds it in position, the wire that connects it to the center of the paper cone, and the paper cone itself all have natural vibration periods both individually and when working together as a unit. When an electrical vibration is sent through the coil that corresponds in frequency with the natural vibration rate of some part of the mechanism the part responds much more readily than it does to other frequencies.

Of course, an ideal loudspeaker would not play favorites in this way, and a large proportion of the research work on loudspeaker construction has been expended in the attempt to construct a unit that would have no natural tendency to vibrate excessively at certain frequencies. This has been accomplished largely by making the parts so small and light that their natural vibration period is outside the range of music or speech or by so damping their action that they respond only in proportion to the strength of the electrical impulses without chance to vibrate on their own account

THE paper cone type speaker has greatly helped in the solution of these problems. It was found capable of transmitting to the air the low frequencies that the ordinary horn speaker completely smothers.

But the size, shape, method of support, and material used in the cone have considerable to do with its abil ty to give forth air vibrations from the deep notes at the low end of the scale to the shrill tones in the upper register.

That is why ordinary brown wrapping paper won't do for a cone. Special paper has to be used, and in many cases the paper, after it has been made into cone shape, is carefully reinforced at various points to prevent resonant vibration effects.

When you buy a loudspeaker, don't be fooled by elaborate design or fancy finish. Get a demonstration with the type of radio set you own and remember that faithful reproduction is the vital feature. Let your ears and not your eyes be the final judges, and unless you are a musician yourself, take along a friend who is. Don't expect a cheap speaker to rival a high-priced one

When you purchase a modern, high-grade loudspeaker, you are not buying a musical instrument, but you certainly are buying a sensitive, high y developed piece of apparatus that will accurately convert into audible music or speech whatever electrical impulses are fed into it by your radio receiver.

Amazing New Jobs for X-Rays

(Continued from page 38)

to take pictures through four and a half inches of solid steel. Further improvements will increase that to six or even eight inches!

In the past, a problem often discussed by automobile makers was the amount of oil required to lubricate an engine properly. The question was settled the other day by the use of the X-ray. It showed that a thin film of oil only a few molecules thick is best.

Recent tests have shown that an X-ray photograph is one of the surest and quickest ways to test the quality of a piece of coal. It reveals the relative percentages of combustible material and worthless ash and mineral.

Another promising new field is in photographing the crystal structure of metals. Every metal is distinguished by the geometrical crystal form in which its molecules arrange themselves. X-ray pictures reveal these tiny forms in light and dark lines, and so distinguish one metal from another in an instant.

A "family album" of photographs of metal crystals is being collected by the University of Wisconsin. Already 170 have been assembled, and soon the collection will include every known mineral of the world—more than 1,100 in all.

HOWEVER, photographing crystals, invisible to the most powerful microscope, is but a step toward more wonderful possibilities. Professor George L. Clark, of the University of Illinois, tells of taking pictures of bits of matter 10,000 times smaller than anything that can be seen through the most powerful microscope. He prophesies that the X-ray will be able to show us not only the molecules and atoms of which all things are built, but even the tiny suns and planets within the atom!

One of the most staggering stories science has to tell is this story that solids are not solid at all: that the molecules and atoms and electrons that make up rocks and buildings and automobiles are not touching like bricks in a wall, but are far apart, moving in space!

When you bang your head on a door in the dark, anyone would have a hard time to convince you that what your head hit was nine-tenths empty space. Yet shortly, according to Professor Clark, you will have pictures that prove it!

Advances in Aeronautics

(Continued from page 78)

The giant camera, said to be the largest in the world, is four feet long and it takes a picture nine by eighteen inches. In military operations the camera enables an unseen plane to picture forbidden areas.

The special camera was designed especially for 30,000-foot altitude work by the Fairchild Aerial Camera Corporation, collaborating with the Army Air Corps at Wright Field, O. It has an electric heater to keep the shutter from freezing at temperatures as low as sixty degrees below zero; and can take a hundred pictures without reloading.

Attack Problem of Icy Wings

WAYS to prevent the formation of ice on airplane wings—one of the greatest remaining perils of air travel—are being tried by the National Advisory Committee for Aeronautics, which is studying the particular weather conditions that favor production of the ice coat.

In wind-tunnel tests, atmospheric conditions are to be simulated and actual production of an ice coat on a model airplane wing observed with a view to finding a means for its prevention. The U. S. Bureau of Standards has contributed to the new research an instrument that indicates to a pilot in flight when ice is forming, and how much.

New Houses for Old

(Continued from page 58)

everything," remarked the young woman, "but tell us something about stucco."

"Stucco insulates less than brick because it is not so thick and provides less air space," said the veteran. "It does away with foundations and angle irons, but requires a continuous backing for attachment to an old wood frame house, although it is put directly on hollow tile and other masonry. For your case the old method was to strip the walls vertically with shingle lath, cross these horizontally with mason's wood lath the same as for inside work, and then slap on the stucco."

"What is the new method?"

"Wire mesh or metal lath sheets that usually dispense with all 'furring' of shingle lath and save material and labor. There is no wood to rot or burn, while the hold of mortar on metal is perfect and the combination is close to reinforced concrete. In theory this layout is without flaw, but, if the metal is not well galvanized or completely covered with mortar on the hidden inside part, it will rust out. And if the stucco is poor or badly put on, it is porous, cracks, weathers, and falls out in chunks."

"HOW does metal lath dispense with furring?" asked Donald.

"It is made self-furring so that it stands out from the wall, or it is fastened with special furring nails which accomplish the same purpose. The nails have a spacer which slips under an edge of the fabric and holds it out a quarter inch or so. Self-furring in the fabric may be a rib which holds the rest of the sheet three fourths of an inch from the wall. A good tar paper should be tacked over the old wooden surface before applying metal. All the little details are important in this kind of work. And it is doubtful economy to use black iron or even painted fabric instead of galvanized, not to mention such a cheap substitute as chicken wire."

"Is there a standard thickness or weight of metal for stucco?"

"Yes, the least weight recommended is three and two fifths pounds a square yard. The size of openings in a fabric should not be more than one and one half by four inches. If the openings are too small the mortar does not cover the back of the metal and if too large the same thing happens along with a waste of mortar that falls through. The proper weight of fabric differs according to the use, whether inside or outside, wall or ceiling; the standard weights are minimum and there is nothing to prevent using a heavier material, which might be advisable in case of an old poorly built house."

"WHAT is the best way to attach metal lath to our walls?" inquired the husband.

"First of all we should lap the sheets at all joints, an inch on the sides and two inches at ends. Some people wire the side joints together. No joint should occur at corners or angles, but the fabric should be bent around them for a distance of a foot. Only furring nails, or staples if the fabric is self-furring, should be used—every six inches vertically and every foot horizontally. Staples should be galvanized and at least an inch long. It is well not to drive them too tight, so as to give the building a little freedom of movement behind the stucco. In some fabrics there is a right side up to be observed: the mortar rests on shelflike projections of the lath if it is rightly placed, otherwise it tends to slide down and out. And in lapping side joints it helps the mason to have the lower strip lap over the upper."

"What is the proper thickness for stucco?" asked the young man.

"Not less than seven eighths inch. Three coats are usually applied, but two coats may be satisfactory as long (Continued on page 130)

New Houses for Old

(*Continued from page 100*)

as the same total thickness is attained.

"Is it necessary to use waterproofing compounds?"

"Experts of the Portland cement industry say no, but thousands of builders go right ahead using the old recipes mixed with a few modern notions. The Government scientists in the Bureau of Standards doubt that lime contributes anything to stucco except ease in working, and for this purpose eight pounds of hydrated lime to one bag of cement is enough. With Portland cement and metal lath there isn't much excuse for hair now. There is also a doubtful common practice of varying the richness of the different coats in stucco. The best advice is a uniform mixture of one part cement to three of sand for all coats.

"Allow one day between the first two coats. If there is a third coat, it follows a week later. It is important to keep the job damp by spraying for several days, and careful workers sometimes hang tarpaulins over the walls to protect the stucco from premature drying."

"Perhaps you can guess my final question, Mr. Dinsmore," said Ada.

"I think so," laughed the veteran. "You want to know just everything about stucco color and finish. Well, you have your choice of about a dozen beautiful finishes and any colors you ever saw at a ribbon counter. Of course, Don will bear in mind a couple of practical details—that the colors should be meant for stucco use and that not more than nine pounds of any color are mixed with each bag of cement."

Uncle Sam's Mechanical Army

(*Continued from page 81*)

speed. From the rear, huge motor trucks dash up and disgorge both men and horses at the front, fresh for battle. Infantry and cavalry have arrived by motor!

The imaginary enemy—the hostile force of a foreign power—has steamed up the American coast in battleships and, disembarked, is threatening Washington, scouts have reported to the commanding general of the Third Army Corps Area. Expecting desperate resistance, the invading troops have advanced cautiously across Maryland soil. There has been no resistance—and reconnaissance has shown no defending force within miles. Reassured, but puzzled, the enemy has encamped for the night in a clearing near Camp Meade.

Then the surprise attack. First, an ominous, distant rumble like the firing of far-off cannon. It comes nearer, grows into a roar. Over the tree tops race two American observation airplanes, advance guard of the attackers.

From trees that border the camp poke the noses of tanks, metal monsters that dash upon the sleeping enemy. Into their ranks they race at automobile speed, spitting destruction from their stubby gun barrels. Behind them come hordes of horsemen fresh for the combat. Shells whine overhead from guns rushed to the front.

The enemy is wiped out. An American motorized force, miles away at dawn, has sped into action so swiftly that the invaders never had a chance to escape before they were overwhelmed. That is the essence of the Gasoline Brigade—speed and surprise.

From all branches of the service has been taken the personnel of the Gasoline Brigade now smashing the ranks of imaginary enemies at Camp Meade. A battalion of infantry, a battalion of field artillery, a troop of cavalry are only a part of it. There are antiaircraft guns, also motorized; light and heavy tanks, a motor ammunition train, engineers, signalmen, medical corps men, and even a squadron of observation planes.

"Folks, That's Ramblin'!"

(Continued from page 17)

former flights Will had worn his regular clothes, but for this cross-continent hop he rigged himself out in a snappy flying suit—a leather affair, "sort of a cross between pajamas and bib overalls." The pilot took one look and then suggested that the day was much too warm for a flying uniform.

"Well," said Will, "that spoiled my whole day. I felt as bad as the old-fashioned motorist would have felt if you had taken away his linen duster and his gauntlet gloves!"

Will paid $60 for the first hop, Los Angeles to Salt Lake, and, minus his trick suit, crawled into the cockpit at 7:35 o'clock of a fine Tuesday morning. It was a Douglas plane, powered by a 425-horsepower Liberty motor, one of the regular mail and passenger ships of the Western Air Express. This time Mrs. Rogers had packed his grip, and, rummaging in it for something to eat high over the Nevada desert, Will made an alarming discovery.

"PAJAMAS! I guess she thought I was going to take off my clothes over Wyoming that night, brush my teeth, put the cat out on the wing, and wind the speedometer, and have the pilot come over and tuck me in.

"But there were sandwiches! She had 'em hid as usual. Just another woman! She thought I couldn't find them, but I fooled her."

At Salt Lake City Will changed to a Boeing Line plane, paid $144 for his ticket to Chicago, and settled down in the cockpit for his night-flying.

"I had flown at night in Germany, but never over here. We commenced seeing those revolving beacon lights. They are placed about every twenty-five miles, and lots of them have a row of little lights around that kind of look like the size of a baseball park. Those are the ones that have emergency landing fields, and these air mail pilots can land in the dead of night with no danger at all.

"A well-lighted field at night, with planes coming in, just reminds you of a carnival at Coney Island. It's a real kick, landing on a real lighted field at night. It makes you feel like we are really getting somewhere with our aviation."

He arrived in Chicago at 7:30 the next morning, and had breakfast at the Maywood flying field. In a ship of the National Air Transport, he took off at 9:30 A.M., and landed in Cleveland.

IN CLEVELAND the pilots and weather experts were a little concerned about atmospheric conditions between there and Bellefonte, Pa., but a pilot and Will went and got through, although the passage was rough and Will said he "liked to ruined some of Uncle Sam's best mail sacks" piled around him in the cockpit. At Bellefonte he got into a plane for New York with a new pilot, but soon they were beset by fog, clouds and rain. The pilot picked out a nice pasture field, skimmed a fence, and landed. Farmers saw them go down, and came a-running. Will bade a sad farewell to his luckless pilot, and drove overland twenty-five miles to catch a train for New York, where he arrived about midnight.

His business attended to the next day, the flying Mr. Rogers prepared himself for air mail delivery to his California home and discovered, to his amazement and indignation, that he would have to take a railroad train to get to a flying field! It was Hadley Field, out of New Brunswick, N. J. A municipal airport for every important city is one of the biggest planks in the Will Rogers Platform, and he raved about it all the way to the field.

"There are twenty golf courses nearer New York than any flying field they have, and it takes less ground to land on than to make a golf course on," Will growled. "Yet the Biggest City

(Continued on page 132)

"Folks, That's Ramblin'!"

(Continued from page 131)

in the World has no regular place to land!"

The trip back to Chicago was made without incident. Leaving Chicago at 8:30 that night, Will made a pillow of his overcoat, curled up in the cockpit, and slept like a baby. They had to shake him awake at Omaha to change planes. The ship had landed at Iowa City, Ia., for gas, and Will had slept through it all.

Landing at Cheyenne, just at daybreak of the fourth day, they changed planes again and Will reached Los Angeles at 5:15 P.M., Friday afternoon. Mrs. Rogers was there to meet her sky-hootin' husband, a little worried about him.

"Should have been the other way around," Will said. "She had the narrow escapes, driving out to see me land. An Iowan in a flivver hit 'em crosswise, but they shoved him off before any serious damage was done.

"You don't have to stop to figure which is the safer—an automobile or an airplane. All you have to do is compare the intelligence of the men that pilot planes with the intelligence of everybody that drives a car!

"My friend," went on Will, "was some place between Cleveland and Buffalo, and wouldn't reach New York until 9:30 the next day. And here I was—right back where I started from four days before. Folks, that was ramblin'!"

THIS autumn the comedian will be up in the air, preaching his travel-by-plane gospel in between his dry, drawling anecdotes and philosophy.

The air mail links the coasts, the north and south. The planes daily cover twenty-four routes of nearly 15,000 miles, with seventy-five station stops. The Government maintains more than 7,500 miles of lighted airways, 141 intermediate fields with beacon and boundary lights, 719 airway beacons, and seventeen radio stations. Last year, over twenty-nine established airways in the United States, planes flew 5,870,460 miles, carrying 8,670 passengers, 2,403,480 pounds of express, and 1,034,163 pounds of mail. Nine actual transport operators carried 30,916 passengers for a total distance of half a million miles. These are the official figures of the U. S. Department of Commerce. The average passenger fare on fourteen commercial air lines was about ten and a half cents a mile. Activities of private commercial aviation companies and flyers are growing so rapidly that it is difficult to keep pace with them.

Planes are flying every day to every point of the compass. And, as Will Rogers says, "anyone can walk down and pay his fare and go."

What Lettering on Planes Means

LETTERS painted on Navy planes disclose to the initiated the type and builder of the plane, the purpose for which it is used, the type of engine, and often additional information, according to the Navy's latest revised code book. "V" as a prefix is used on airplanes alone, indicating heavier-than-air craft, dirigibles would use the letter "Z." "VF," "VP," and "VS" designate fighting, patrol, and scouting planes respectively. There are eight such classes. Additional numbers and letters indicate the squadron and fleet.

The designation (A) denotes an air-cooled engine, and (W) water-cooled. Each manufacturer also has an assigned letter, usually the first initial of his name. An "X" is prefixed to planes of experimental design and dropped when they are accepted for service.

Different letter and number combinations are used for commercial and air mail planes, which do not come under Navy regulation. These are simply individual license numbers assigned by the United States Department of Commerce.

Tuning-In Short Waves

(Continued from page 4?)

you connect the ground binding post of the battery type unit shown in Fig. 1, check over the wiring in the broadcast receiver and find out which side of the filament circuit is grounded. If you find it to be the plus side, proceed to connect the ground binding post of the short wave unit to the ground binding post of the broadcast set, but if you find that the minus side is grounded or there is any doubt as to which side is grounded, play [illegible] and connect the ground binding post of the short wave unit to the ground binding post of the broadcast set through a fixed condenser so as to avoid any chance of short-circuiting the A battery. Any size fixed condenser can be used, not less than one tenth microfarad.

The best antenna for short wave work is a short outdoor antenna, about forty feet long, very carefully insulated and located as far as possible from any metal work.

OF COURSE, if you cannot put up a separate antenna for short wave work, excellent results can be obtained in most cases by using your regular outdoor or indoor antenna. A simple arrangement, if you desire to do this, is to connect the antenna lead-in to the center terminal of a single-pole, double-throw, porcelain-base battery switch and connect the outer terminals to the antenna binding posts of the broadcast receiver and the short wave unit respectively. Thus, in one position the broadcast set is connected to the antenna and in the other position the radio waves will flow through the short wave unit.

It is desirable to use a vernier dial on the shaft of condenser *D* because the tuning on the short waves is exceedingly sharp, but a large knob or plain dial will suffice on condenser *E*, which controls regeneration.

Tuning the short wave unit is simple. The wave length setting is found on *D* and regeneration is controlled by *E*, the setting of *E* having little if any effect on the setting of *D*.

When you are attempting to tune-in short wave broadcasting or amateur phone stations, condenser *E* should be kept at a point just below oscillation while you slowly turn *D*. But if you are searching for amateur code stations where the transmission is of the continuous wave variety, condenser *E* must be turned just far enough to keep the receiver oscillating; in other words, just beyond the point where ordinary broadcast signals are converted into a whistle by the oscillation of the tube in the short wave unit.

THE tone of the amateur code signals can be shifted up and down the musical scale by turning either condenser a trifle.

If you fail to get results of any kind when you turn condenser *E* up from zero setting (plates fully disengaged) and you are positive that there is nothing wrong with the wiring, the chances are that the connections to coil *C* should be reversed.

Coil *A*, as you will note from the illustrations, is mounted so that it can be swung away from coils *B* and *C*. A little experimenting will show you the best average position for the coil. The type of antenna you use largely governs its position. If coil *A* is too close to coil *B*, you may find several locations for condenser *D* with the various coils where you cannot throw the set into oscillation by turning *E*. Moving coil *A* farther from coil *B* usually will remedy the trouble.

The Popular Science Institute of Standards has tested and approved various makes of parts for use in constructing these short wave units. If you desire information on this point or on any other details, address your letter Radio Editor, POPULAR SCIENCE MONTHLY, 250 Fourth Avenue, New York City.

Flying Planes without Motors

(Continued from page 83)

have been made, pilots "hop" from hill to hill to stay in the air. Even over flat country there are erratic rising air currents, caused by the sun's heat, that would help to sustain a glider in flight; a motor flyer calls these "bumps" in the air.

Today's glider pilot, instead of hanging precariously from a glider and balancing it by swinging his own body, as in the old type craft, sits in a comfortable cockpit. He steers his machine into the wind with control levers, exactly like an airplane's, that operate the rudders and flexible wing surfaces or ailerons. With such controls, he is independent of the wind's direction to much the same degree as the pilot of a sailboat. Just as a sailing water craft takes an indirect, zigzag course when the wind is unfavorable, so the glider pilot can make progress toward any destination no matter which way the prevailing wind is blowing simply by ascending straight into the air and then gliding downward toward his goal.

THE take-off is a stirring affair. A windy day is chosen. The glider, a streamlined feather-weight craft of thin plywood framework and light woven linen wings, is poised on a hilltop. To a hook at the bottom of its nose, several men attach a double towrope of rubber as thick as a man's finger. A gust of wind sweeps the hill. Already the pilot has climbed into the cockpit, strapped himself in.

"Let 'er go!"

Half a dozen men race down the slope, dragging the machine at increasing speed as if it were a kite being launched. Others run beside it, holding up the fragile wings from contact with the ground until they seize the air and lift the craft.

"Free!" shouts the pilot. They let go. The towrope falls off and the loosed glider soars over their heads.

There is no noise, no smell—only the beating of the wind against the wings. The pilot can lean over the side of his craft and talk to those on the ground over whose heads he is circling. Like some giant crane, the great soaring bird wheels and glides on motionless pinions. A novel ceremony based on this fancied resemblance is in vogue at a Rossitten, Germany, training school for glider pilots, where the "call of the crane" is a salute accorded pilots returning from a successful flight. Spectators on the ground vent their applause by standing on the right leg, stretching forth the left hand, and imitating the bird's note.

IN GUSTY weather a pilot may have to exercise all his skill at the controls to keep his craft headed straight and on an even keel. Hanging suspended, motionless, in a powerful upward air current, is an odd experience occasionally met with by pilots, among them the German flyer, Botsch, who took off halfway up Mt. Wasserkuppe and landed a few seconds later at the summit.

When, on a flight, a pilot continues to lose elevation, he must land as best he may. Light in weight, a glider descends with a leisurely forward motion to a safe landing on its airplanelike skids; it is, in effect, its own parachute. Add to this the absence of fire hazard from gasoline, and the safety of a forced landing is apparent. A skillful pilot, however, can generally return to his starting point by air; he lands immediately after the take-off if he finds the breezes unpromising.

Since a glider depends upon the wind to keep it aloft, and the wind sometimes fails, it is not surprising that experimenters have tried their hand at building craft with auxiliary power. Man-power machines are still in the experimental stage. One of them, an "ornithopter" or flapping wing craft, propelled by foot power, is being tested by its inventor, George White, at St. Augustine, Fla.,

(Continued on page 155)

Flying Planes without Motors

(Continued from page 124)

where it is said to have flown. Another inventor, Lehman Weil, of New York, has completed a model of a hand-propelled glider with movable wings. Available records cite only the modest mark set by a Frenchman's man-propelled glider, which won its inventor, G. Poulain, a $2,000 prize by flying with its pilot for more than thirty feet at a height exceeding three feet from the ground.

But with a gasoline motor, it is a different story. The combination of a lightweight glider and a motor no larger than a motorcycle engine makes an ideal sailing plane, independent of the wind, that can even take off from level ground. It differs from an airplane in that the pilot can shut off his engine and soar as a glider for hours. Then, when the wind fails, he starts his motor and "putt-putts" through the air at a loafing pace of, say, fifty miles an hour.

A German named Kegel added a fourteen-horsepower motor to his glider, flew under power to a height of two and a half miles, shut off the engine, and soared entirely around the Bavarian Alps. His gasoline cost him one dollar for the trip.

Low cost is one of gliding's chief attractions. It offers the thrills of motored flying, and more, at a fraction of the expense. A good "school glider," or training machine for the beginner, can be built for about $150; for safety's sake, he should not attempt to build the glider himself, the American Motorless Aviation Club warns. Such a training machine is heavily built and capable only of short downward glides; others, for more advanced pilots, are frailer and can soar upward for long-distance flights. The finest of them, equipped with airplane instruments, and a motor if desired, cost from two to three thousand dollars—about where the prices of small airplanes begin.

ANY hillside 500 feet or more high, and devoid of trees and rocks, offers suitable headquarters for a local gliding club of ten or a dozen members. Four to ten persons are required to launch a glider.

Abroad, large gliding camps are national centers for enthusiasts who keep their gliders there and motor to the camp to fly them. Soon the American Motorless Aviation Club plans to establish similar camps, with hangars, workshops, a training field, and camping quarters, throughout the United States to serve as centers for local clubs. They would be, also, vacation spots for would-be glider flyers who have no hill at hand and who cannot afford a de luxe motor-glider.

At such camps, gliders would be built, training courses provided, and gliding meets held. Anyone can fly a glider, the American Motorless Aviation Club asserts; and it plans courses of instruction including one that prepares the novice for his first solo flight—a short, fledglinglike hop at a height of, say, forty feet, while the instructor shouts directions from the ground.

What effect will the growth of gliding have in America? At this time, one can only guess. But it means, certainly, that we have a new, thrilling sport—a sport that may be of profound benefit in training future air pilots. And it is even possible that out of one of today's developments—the low-power, soaring motor-glider—may come the private "flivver" airplane of tomorrow.

Today's Planes "Just Kites"

FUTURE airports will be huge concrete platforms a mile square or even larger, according to Capt. E. V. Rickenbacker, American war ace. The largest planes of today, he says, are mere kites compared with tomorrow's monsters; and in five years the concrete airport will be as commonplace as macadam roads are today.

A Scientist of Wall Street

(Continued from page 43)

The experimenters connected quartz crystals with a high-frequency electric oscillator, somewhat like the oscillators used in radio transmission or in electric furnaces. Amazing things happened. They found that if the quartz plates were suspended in air and attuned to electric current of 50,000 volts pressure, oscillating 300,000 times a second, the vibration would hurl the quartz to pieces! To prevent this, they immersed the quartz in oil.

Immediately, the oil, catching the vibrations, rose in the form of an erupting volcano three inches high, and from its crater droplets of oil shot a foot into the air.

But that was only a beginning. Next they took a small glass tube and drew one end of it out into a thread of glass as thin as a hair. The other end they dipped into the turbulent oil. The tube was shaken with unheard sound. When Loomis held the thread lightly between his fingers, he felt no trace of the upheaval. But when he pressed the thread tightly, it burned a deep groove in his skin. And the same harmless-looking thread burned holes through wood and bored through plate glass like a power drill.

Soon Loomis and Dr. Wood applied the strange discovery to living things to see how they would react to the "death whisper." For this, they called in Dr. E. Newton Harvey, Professor of Physiology at Princeton University, a national authority on living cells and the lower forms of life.

Looking through high-power microscopes, they saw the super-sounds tear apart a tiny one-celled creature and kill it. Similarly, the vibrations broke down and sterilized human red blood corpuscles. They killed small frogs.

Already a number of valuable applications are in sight. As this is written, the Bureau of Chemistry and Soils of the U. S. Department of Agriculture is preparing to use the waves of burning sound as an aid in the analysis of soils. Heretofore, this work has been hampered by the difficulty of separating sticky substances which cling to the grains of soil. It has been done by the tedious process of violently shaking and whirling the grains. Now Loomis and Wood have demonstrated that the super-sound will shake the grains clean in a few minutes.

AGAIN, because of their remarkable effect on the red corpuscles, it has been suggested that the vibrations may aid chemists in analyzing blood. And Dr. Harvey has declared that the waves of sound "offer a promising means of attack upon the problem of influencing the development of eggs of various species, as forces can thus be applied inside an egg at different stages of its development without the necessity of puncturing the cell wall." With super-sounds Loomis and Harvey actually have succeeded in developing two small frog embryos in an egg cell which normally would produce only one.

Like other men who have hobbies, Loomis likes company in following his. Time and again he has thrown open his laboratory, with its modern equipment, to other investigators. Not long ago, for example, he turned the laboratory over to Dr. Frank E. Lutz, curator of entomology at the American Museum of Natural History. He and Dr. Lutz together devised interesting scientific tricks with a cricket. Placing the insect in a container of compressed air, they whirled him around in a machine for ten minutes, at the rate of 1,200 times a minute. The cricket survived the ordeal! Dr. Lutz found that the insect was protected by air pockets within his shell.

Loomis, hard-fisted man of affairs, is reticent about his laboratory and his achievements. He likes best to pursue his pastime with his friends, without the public eye upon him. That he has helped to discover what apparently is the "missing link" between sound and heat has served merely to add zest to his hobby.

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